POWER

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Candid Chats

The Human Element

THE PERSONAL relation of the chief to his men controls *the human element*. If you daily parade your authority as chief and form the habit of using the pronoun "I" instead of "we" it won't take your men long to form the opinion that you are autocratic, and antagonism will be the result. Working with your men gives an atmosphere of fellowship and creates good will.

Perhaps one of the greatest detriments to teamwork and plant harmony is the frequent issuing of harsh and peremptory orders. Put your wishes in the form of suggestions or instructions. When you see that certain things can be done in a better way, make the suggestion that it be tried, thus leaving the men a chance to offer improvement of the plan.

Treat the men as individuals. When you use them as a part of the plant machinery you only succeed in submerging their individuality and likewise their initiative and progress. *The human element* is most vital in the maintenance and success of the plant, and any treatment that minimizes this important element is bad for you and for the business. If your plant force is small it is easy for you to personally know each one of your men, and in your contact with them, a "Hello, Frank, how's that youngster getting along?" gives a human-interest touch and cements the bonds of plant fellowship, shows the man that you are interested in him and makes it an easy thing for you to adapt him to your ideals.

When the plant organization is so large that this personal touch is not possible you can easily pick for your staff those who are in sympathy with your own ideas and delegate to them your authority. But after you place this responsibility upon their shoulders, don't tamper with their work, for if you change their orders to their men, etc., it is but a confession that you do not trust their abilities. You must consider them equal to their jobs or replace them with men whom you do. Give full authority to each department head to do as you would do; let the feeling be that plant success is a matter of common purpose.

Your office duties even as chief or superintendent of a large plant should never absorb your time to such an extent that frequent trips through the plant are impossible. Make it a point to know each engineer and department head as well as the leading men, and mingle enough with the oilers, firemen, coal passers and repairmen so that they will at least know you and get plenty of chances to form an opinion of what the big boss looks like. This will be a point in your favor, too. You must be a real personality to them and not a mere name.

Contributed by Charles H. Willey

Low-Pressure Turbines in Forge Shops*

By H. V. SCHOEPFLIN†

Economy of utilizing exhaust steam from hammers instead of wasting it to the atmosphere. Details of apparatus required and problems to be considered in the application.

THE same principles that make the turbine using high-pressure steam an economical machine apply to the turbine receiving its steam at about atmospheric pressure and exhausting to condenser vacuum. In the low-pressure section of a steam turbine a proportionately greater percentage of the available heat energy is actually converted into work than in the high-pressure section because of the lesser friction and leakage losses. The low-pressure portion of a high-pressure condensing machine may be built either into the same cylinder with the high-pressure, or in a separate cylinder receiving its steam from the high-pressure cylinder through a suitable connection. The principle is exactly the same as that of a compound reciprocating

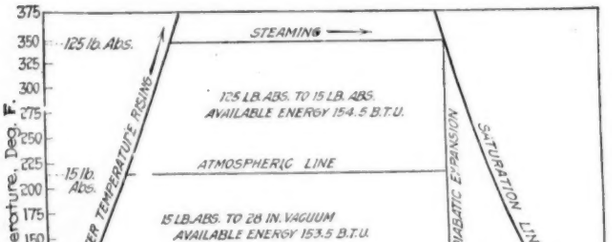


FIG. 1. TEMPERATURE-ENTROPY DIAGRAM SHOWING ENERGY AVAILABLE ABOVE AND BELOW THE ATMOSPHERIC LINE

engine with the added advantage of the turbine being able to utilize to greater advantage the high vacua obtainable with modern condensing apparatus. It makes no difference whether the low-pressure turbine receives its steam from a high-pressure steam turbine with which it may be compounded, from a reciprocating engine or from any other source from which steam may be obtained at or about atmospheric pressure.

Thus it will be seen that the low-pressure steam turbine is well adapted for the conversion into useful work of the large amounts of exhaust steam usually wasted in a drop-forge plant using steam hammers. This exhaust steam contains a much greater amount of available power than may be realized at first thought. Nearly as much heat energy is available in the expansion of a pound of steam from atmospheric pressure down to a vacuum of 28 in. of mercury as in an expansion from a pressure of 125 lb. abs. to atmospheric. A comparison between the heat energy available above and below atmosphere is graphically shown in the temperature-entropy diagram, Fig. 1.

Inasmuch as a great many forge shops at the present time are using boiler pressures of about 125 lb. gage, this pressure has been used in the diagram. The area of the space above the atmospheric pressure line, marked 125 lb. abs. to 15 lb. abs., represents the heat energy available for use in the hammers, figuring on a pressure drop from the boilers to the hammers of 15 lb.; and the area below this line, marked 15 lb. abs. to 28 in. vacuum, represents the available energy wasted if this steam is being discharged to the atmosphere. Inasmuch as the steam hammer is as a general rule a wasteful and inefficient heat engine in itself and the steam turbine the direct opposite, the proportional waste of energy is greater than shown by the diagram. The power may be generated in either the mechanical or electrical form and used for any purpose required.

When it is desirable that this waste energy be recovered, the first requirement is to provide proper means for collecting all the steam exhausting from the hammers. In most existing forge shops where any considerable number of steam hammers are in use, a portion of the exhaust is utilized in feed-water heaters or other boiler-room auxiliaries or for heating, and where such is the case the usual arrangement is to exhaust all the hammers into a common header or steam pipe of the proper diameter. This header performs the functions of a receiver of fairly large capacity, from which the steam to be utilized is taken and the remainder discharged to the atmosphere through a relief valve. When installing a turbine where this arrangement is in use and the conditions are such as to make it desirable, the existing exhaust piping can be used without any great amount of rearrangement, provided the size of the main header and the branch lines is sufficient to keep the pressure drop down to a reasonable amount. The turbine may then receive its supply of steam directly from the header with the interposition of a constant-pressure valve to keep a uniform back pressure on the hammers. Atmospheric relief valves are provided in the exhaust line as before, which valves open only when the exhaust-steam supply becomes greater than that required.

From the header the steam, after having the moisture and foreign matter separated from it, is supplied to a low-pressure turbine through a throttling-type valve controlled by the turbine governor. This valve regulates the steam supply in proportion to the load requirements and maintains a practically constant speed. The percentage of available energy recovered from the exhaust steam of course depends upon the efficiency of the turbine.

As important as the turbine itself is, it is the condenser with its auxiliaries which make possible the entire application. By referring again to the temperature-entropy diagram, the reason for this becomes obvious, as it will be seen that if the line representing steam condensing is moved down to a lower point of absolute pressure, the area of the space below the atmospheric line immediately becomes greater, which

*Abstract of paper read before the American Drop Forge Association, Pittsburgh, Penn.

†With the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Penn.

means that a greater amount of heat energy is available per pound of steam.

In the low-pressure header the use of some form of constant-pressure valve is made necessary by the fact that with any type of turbine the inlet pressure at light loads is below atmospheric, and as it is highly undesirable to have a vacuum in long large lines such as the steam hammers exhaust into, some means must be provided for preventing such a condition. Without it the back pressure on the hammers would vary considerably as the load on the turbine varied, and at times this back pressure would be below atmosphere so that air would be drawn into the header through leaky flanges and pass through the turbine into the condenser to reduce the vacuum.

A constant-pressure valve adapted to this class of work is shown in Fig. 2. It comprises a piston-type valve operated by the pressure in the header. The top of the piston is open to the atmosphere and the bottom to the pressure in the header. If this pressure rises above that for which the valve is loaded, the valve will of course lift and the opening for flow increase. If the header pressure falls below that for which the valve is loaded, the valve will drop until the area for flow has decreased a sufficient amount to restore the pressure balance. If the exhaust-steam supply fails entirely, the valve will close, shutting off the turbine and condenser from the header.

Fig. 3, a longitudinal cross-section of a low-pressure turbine, shows the path taken by the steam through the blading. This particular turbine is of the double-flow reaction type, the blading being so arranged that

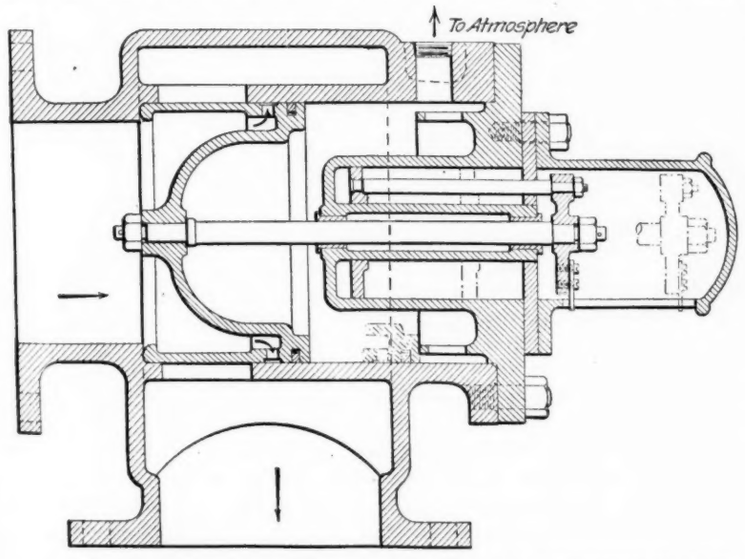


FIG. 2. SECTIONAL ELEVATION OF CONSTANT-PRESSURE VALVE

the steam, after entering the central portion of the cylinder, divides and flows in opposite directions through separate groups of blading to the exhaust chambers, whence it is carried to the condenser through a Y-connection. The blading is made up of alternate stationary and moving rows of what is known as reaction blading, and the flow of steam through this blading is equal in each direction, as shown by the arrows in the sectional view. The turbine is not limited to the double-flow type, but may be built also with the flow of steam in one direction and with one exhaust nozzle, provided the desired capacity and speed will permit.

The governor is of the flyball type and operates the admission valve or valves through an oil relay system. The sectional view, Fig. 4, shows the construction of the governor and the relation of the various parts. The governor spindle is gear-driven from the turbine shaft, and as the centrifugal force of the weights is dependent upon the speed, the spring is proportioned for the range of turbine speed desired. The motion of

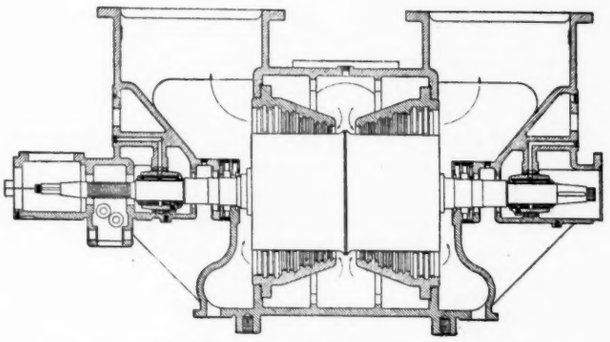


FIG. 3. SECTION THROUGH DOUBLE-FLOW LOW-PRESSURE TURBINE

the governor weights changes the position of the clutch, which is connected by a system of levers to a relay valve. This relay valve controls the admission of oil at a pressure of approximately 50 lb. to the operating cylinder which opens or closes the admission valve. The effect of a change in the position of the weights therefore changes the position or opening of the main valve, thus regulating the inlet of steam in accordance with the demands of the load.

Where the amount of exhaust steam available varies, there is usually incorporated, in addition to the low-pressure steam valve, an auxiliary live-steam admission valve, which is also under control of the governor. This arrangement precludes the possibility of the generating capacity of the turbine being reduced or entirely lost owing to a deficiency in the supply of exhaust steam. The general construction of a steam chest which is adapted for use with low-pressure turbines and which includes an auxiliary valve for the admission of high-pressure steam is shown in Fig. 5. The operating cylinder is under control of the governor through the medium of a high-pressure oil relay system, both valves being under governor control as they are lifted in turn by the single main operating lever attached to the rod of the oil-operated piston. Adjustment of this mechanism is made so that the live-steam valve does not open until the maximum load that can be carried on low-pressure steam alone is reached. The auxiliary valve thus allows the unit to adapt itself to any condition, even to the extreme of generating full rated load on live steam, the steam economy during such operation being between 8 and 10 per cent. better, depending upon the pressure, due to the superheat resulting from throttling the live steam.

In brief, the lubricating system that is generally employed, consists of a supply reservoir, surge tank and oil pump driven from the governor spindle by spur gearing, a cooler built like a surface condenser and a strainer to remove foreign matter.

For this kind of service the jet type condenser is favored as there is less difficulty experienced by reason of oil or foreign matter being contained in the steam.

For the attainment of maximum conditions of efficiency when planning an installation of this character, the following considerations are taken into account:

1. Continuity of flow and amount of exhaust steam available exclusive of that used in auxiliaries, for heating, or other uses.

2. Electrical load. Not only must the present demand for electrical energy be taken into account, but also the possibilities for further use of electric power over and above the present demand, provided a sufficient amount of exhaust steam is constantly on hand for producing this increased amount of energy. In other words, it is highly desirable to obtain as nearly as is possible a balance between the latent energy present in the steam being wasted, and the electrical-load requirements that can be met by making use of this steam.

3. Water supply for the condenser is of great importance, as to obtain the best economy the low-pressure turbine must be exhausted to the highest possible vacuum, and this requires an ample supply of clean, pure water at a low temperature.

Every plant is more or less a separate and distinct problem in itself, but it is safe to assert that a great improvement in plant efficiency with comparatively little outlay may be secured in any forge shop where the exhaust from as many as eight or ten steam hammers in constant operation may be used for driving a low-pressure steam turbine. Take, for instance, a plant where ten hammers are in constant operation and assume that these hammers (varying in size from 800 to 5000 lb. falling weight) have an average steam consumption of 2000 lb. per hour each. Assuming that the moisture contained in this steam is about 10 per cent. of the whole, a total of 18,000 lb. of dry steam per hour is available for use after the moisture has been properly separated. From this amount of steam approximately 500 kw. of electrical energy may be obtained per hour by the use of a properly designed exhaust steam turbine. If the plant in question had been using previously about this amount of power and had purchased it from a local central station at a cost of, say, 2c. per kw.-hr., the power generated by the turbine would be worth $10 per hour or $1 per hour for each steam hammer in the plant, and would be obtained without additional consumption of fuel. Against this saving would, of course, be charged the interest and depreciation on the original investment, slightly increasing operating costs and other standing charges, all of which might vary considerably in amount, depending upon local conditions.

In one forge shop, where a low-pressure turbine had been in operation since March, 1917, and the steam supply had been obtained from an average of 13 hammers running continuously ten hours per day excepting Saturdays, the average amount of electrical energy obtained was about 2700 kw.-hr. per day and the capacity of the turbine 300 kw. Only 40 per cent. of the exhaust steam was used by the turbine and a small percentage used in the heating system and for heating boiler-feed water. No increase in the coal consumption had been observed since the unit was installed, and at the prevailing cost of electricity the saving was estimated as $8000 per year. The boiler pressure in this plant averaged 135 lb. gage, and a back pressure of 10 lb. gage was maintained in the low-pressure header, the turbine exhausting to a vacuum of 27 in. of mercury referred to a 30-in. barometer.

In cases where the electrical load demand is greater than can be taken care of by the amount of exhaust steam constantly available, a turbine of the mixed-pressure type, Fig. 6, may be employed. In this turbine both high-pressure and low-pressure admission valves are used, but the high-pressure valve admits steam through a set of nozzles to a turbine which is of the impulse type. The high-pressure steam expands to a

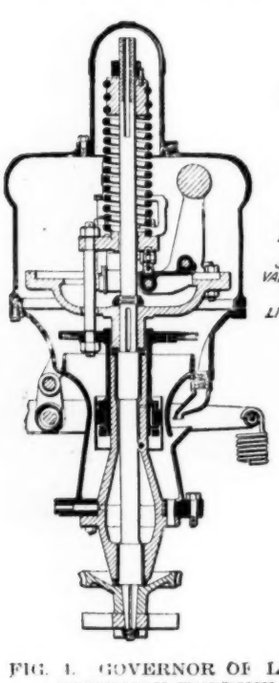


FIG. 4. GOVERNOR OF LOW-PRESSURE TURBINE

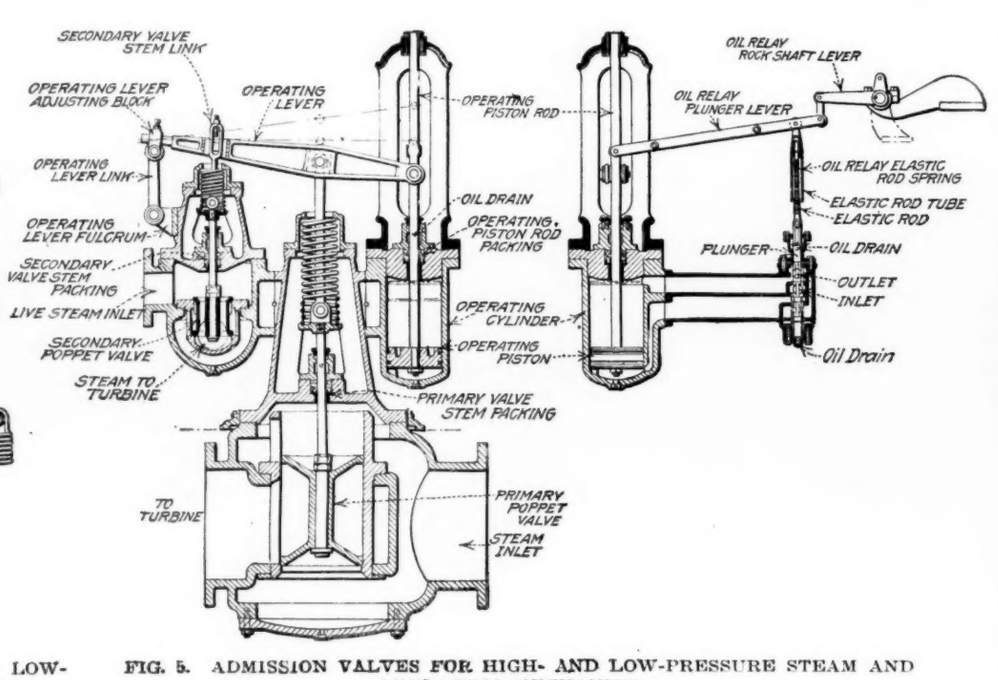


FIG. 5. ADMISSION VALVES FOR HIGH- AND LOW-PRESSURE STEAM AND OPERATING MECHANISM

pressure below atmospheric and imparts its energy to the impulse wheel, the low-pressure steam being introduced at the entrance to the reaction blading. All low-pressure steam is thus put to work and only a sufficient amount of high-pressure steam used to make up the deficiency in load.

In the foregoing the conversion of the heat energy in the exhaust steam into electrical energy only has been discussed. It must be remembered, however, that this latent energy is convertible into power, and with reduction gearing this power may be obtained in various forms. Without the use of reduction gearing the modern steam turbine may be used for the generation of alternating current, and by means of suitable gears may be adapted for driving direct-current generators, reciprocating or centrifugal pumps, mill drive, or for almost any conceivable purpose where the driven apparatus must run at a comparatively slow speed, and the turbine may still be allowed to operate at its most efficient speed.

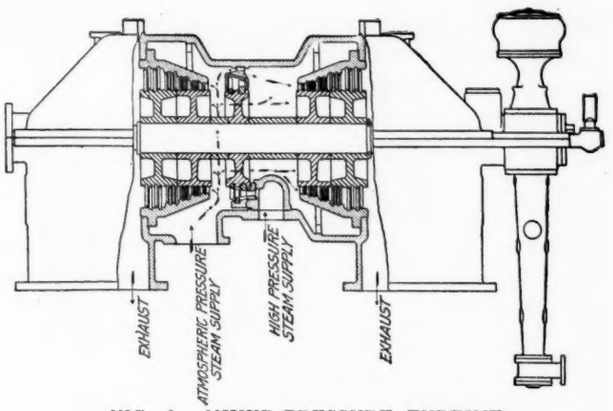


FIG. 6. MIXED-PRESSURE TURBINE

The balance of the paper was devoted to methods of increasing the electrical load to fully utilize the exhaust steam, and the removal of water, foreign matter and oil from the steam supply.

Winton Diesel Oil Engine

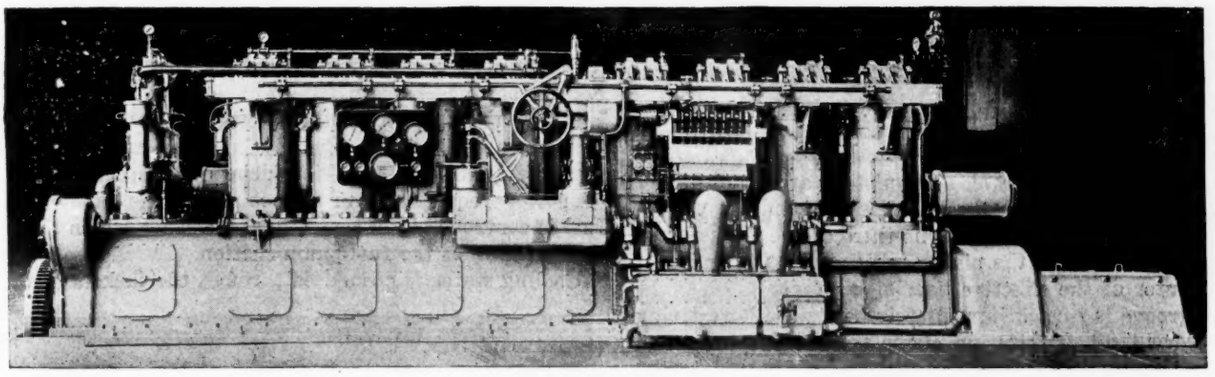


FIG. 1. SIDE VIEW OF THE WINTON DIESEL OIL ENGINE

THE Winton oil engine of the full Diesel type, which formerly was used in the marine field, is now built for stationary service for direct connection to generators (Fig. 1), pumps, etc., or it can be built for belt drive. There are three sizes of the stationary engines with three, four, six and eight cylinders and developing from 50 to 450 horsepower. Inclosed crank cases, trunk-type pistons and crankshaft bearings solidly mounted in the upper half of the crank case with bolted-on-caps are the chief characteristics of this engine, which is manufactured by the Winton Engine Works, Cleveland, Ohio.

The fuel pump, Fig. 2, is of the plunger type, with one plunger for each cylinder. It delivers the fuel to the fuel-injection valve under a pressure of from 1000 to 1200 lb., depending on the pressure of the fuel-injection air. The stroke of the fuel pump is constant, the amount of fuel delivered being controlled by the early or late closing of the pump-inlet valve by the governor. The fuel oil is lifted from the tank to the fuel pump by 10 to 15 lb. air pressure.

The fuel is forced into the cylinder against a compression of 550 lb. by the use of air at about 1000 lb. pressure, which is obtained from a three-stage air compressor mounted at the front end of the engine.

The compressor piston is of the trunk type and is operated by a connecting-rod and a single-throw counterweighted crankshaft bolted to the front end of the main crankshaft. The throw of this single crank is somewhat greater than that of the power shaft.

The capacity of the air compressor, being considerably in excess of that required for the injection of the fuel, provides for the initial charging and maintenance of pressure in the storage tanks, or air bottles, which are used for starting the engine. There are two sets of these air bottles, one carrying the air at about 600 lb. per sq.in. for starting, the second set carrying air at 1000 to 1200 lb. per sq.in. for fuel injection.

The crank case is cast in one piece, of skeleton construction, the sides having large covered openings opposite each throw of the crankshaft. A crankshaft bearing is provided on each side of each throw. The lower part of the crank case forms an oil pan, which extends from the timing gear in the front to the rear of the thrust bearing at the back end of the engine, thus giving a fully inclosed oiling system.

The cylinders are cast individually, with integral water jackets. Large cover plates on the water jackets permit of ready cleaning. Each cylinder head carries five valves—two for the incoming air, two for the exhaust and one for the injection of the fuel. The head also carries the rocker mechanism by means of which

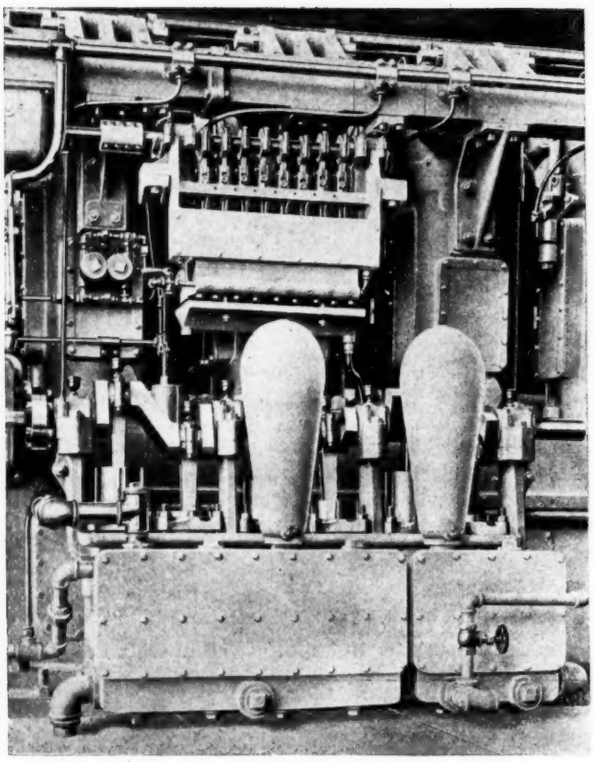


FIG. 2. OIL PUMP AND FUEL PUMP OF THE WINTON DIESEL OIL ENGINE

these valves are operated. The pistons are about 75 per cent. greater in length than in diameter and the piston-pin bosses are located about one-third of the diameter up from the bottom of the piston, which brings them about the center of the effective bearing surface.

A groove is turned immediately below the lowest ring to prevent oil working up above the piston rings, and from this groove a number of holes lead back into the inside of the piston. To prevent oil splashing up under the lower side of the head, the hole through the rib around the inside of the piston is inclosed by a sheet-metal plate.

Each piston rod has an oil tube connecting with the groove in the upper half-box and leading upward to the hollow piston pin, with its end plugged, and is drilled near each end so that oil is fed to the bushings in the piston.

The crankshaft is made in three pieces, two sections having each three or four throws for the power cylinders, and the third section having a single throw for the air compressor.

From each main bearing of the shaft a hole is drilled through the adjacent web of the crankpin. These holes register with grooves in the main and connecting-rod bearings so that the connecting-rod lower bearings are also lubricated under pressure directly from the pump. Each bearing has an individual oil lead to a header running the full length of the crank case. This header is connected to a two-cylinder reciprocating oil pump which maintains constant oil pressure on the bearings.

The camshaft is supported in a long box-shaped casting open at the top. This trough is partly filled with oil, which lubricates the cams and camshaft bearings. The driving gears are fed directly with oil under pressure from the pump.

The camshaft is provided with two sets of cams, for forward and reverse motion respectively. Shifting the shaft endways by means of a handwheel and suitable mechanism brings either set of cams into operation. This is frequently accomplished in five seconds.

In Fig. 3 is shown an assembled cylinder head with valve-operating mechanism and fuel-injection pipes. Each pair of inlet and exhaust valves is operated from the camshaft by a single rocker arm, the valves being connected by a T-head slide on which the end of the rocker rests. The slide is carried in contact with the rocker at all times by a coiled spring in the center of its hollow stem. These pairs of valves are used instead of single large valves, as the small valves are much less likely to warp under the high temperature to which they are exposed.

The fuel-injection valve is located in the center of the head (see Fig. 5) and is also operated by a rocker from the camshaft. The adjusting screw for this valve is set to leave 0.025 in. clearance when the valve is closed.

The valve timing, as regards the air inlet and the exhaust valves, is very close to an average four-cycle gasoline-engine valve timing, the figures being as follows: Air intake opens 5 deg. before upper center; air intake closes 25 deg. to 30 deg. after lower center; exhaust opens 40 deg. before lower center; exhaust closed on top center.

The timing of the fuel injection valve is as follows: Valve opens 7 deg. before upper center; valve closes 25 deg. after upper center.

High pressure-injection air flows all the time the injection valve is open. Fuel is injected, however, during part or all of this period, depending on the amount of power required from the engine. The amount of fuel is controlled by a centrifugal governor which limits the duration of the fuel-pump suction.

Cooling water is circulated through the jackets of the

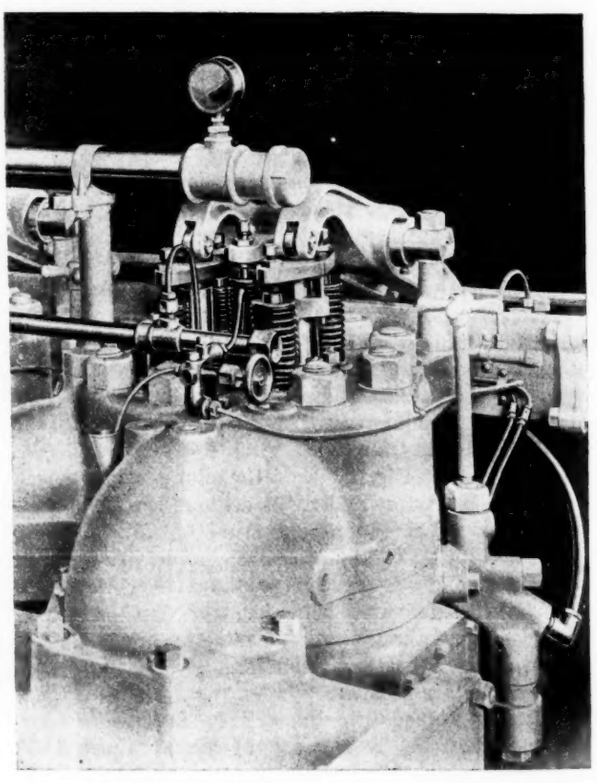


FIG. 3. ASSEMBLED CYLINDER HEAD SHOWING VALVE OPERATING MECHANISM AND FUEL INJECTION PIPES

engine cylinders and the air compressor by a four-cylinder plunger pump operating from the same small crankshaft which handles the oil-circulating pump.

The oil-circulating system, which provides lubrication for all the main bearings of the engine, is supplied by two single-cylinder pumps. The one driven from the end throw of the crankshaft operating the circulating

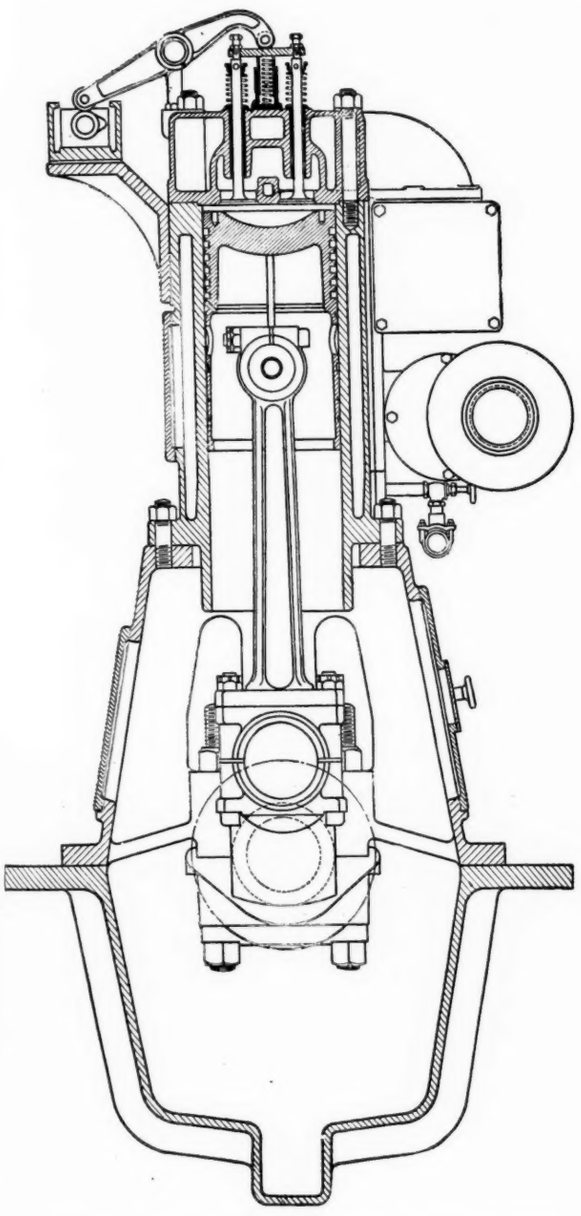


FIG. 4. SECTIONAL ELEVATION THROUGH THE WINTON ENGINE

water and lubricating oil pumps draws the oil from the well in the lower half of the crank case and forces it through a cooler and a strainer to a storage tank. The other pump draws the oil from this storage tank and forces it into the header, from which it is piped to the bearings. The circulating-water pump is of the four-cylinder type and also has an air chamber on the discharge side to insure steady circulation of water. The cylinders, pistons and stuffing-box glands are made of bronze to prevent injury by the water. An end sectional elevation of the engine is shown in Fig. 4.

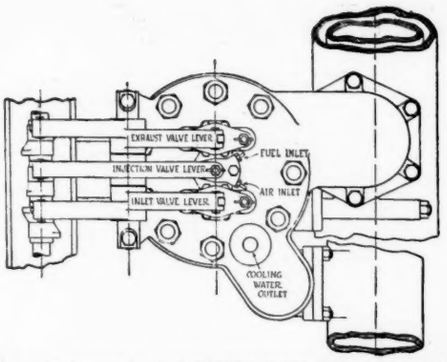


FIG. 5. TOP PLAN SHOWING LOCATION OF VALVES

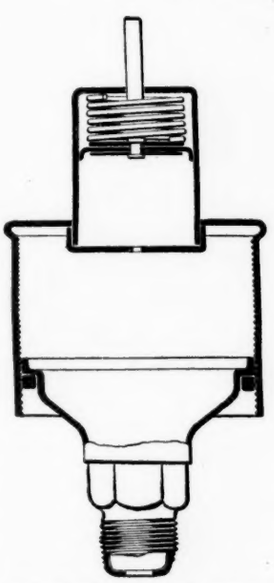
Pressure delivered by the air compressor is as follows:

High-pressure cylinder	1050	1200	1175	1150	1225
Intermediate cylinder	200	295	280	280	325
Low-pressure cylinder	60	60	60	60	60

The camshaft runs one-half the engine speed and the oil and water pumps two-sevenths of the engine speed.

New Standard "Duplex" Grease Cup

The New Standard "Duplex" grease cups embody a departure from the usual method of feeding grease, making the use of fluid pressure instead of the ordinary spring pressure. The cup is in two parts with a diaphragm between, in which is a small hole through which the grease passes into and out of the top portion, or feed chamber. This contains a spring-actuated plunger with a stem that protrudes through the top and serves as a sight-feed indicator. Thus the plunger is acted upon by a spring pressure above and a fluid pressure below, and the grease moves alternately in the direction of the stronger force. When the lower portion, or reservoir, is filled with grease and screwed down on the base, the fluid pressure thus created drives grease through the diaphragm, raises the plunger and sets the indicator, and at the same time drives grease through the shank, in contact with the bearing. As the bearing uses up the grease, other grease automatically takes its place, the feed pressure being simply sufficient to keep a column of grease in constant touch with the bearing. In the "Duplex" cup the feed chamber can be filled from four to ten times for each filling of the reservoir cup, according to the size of the latter; but in the "Auto-Twin-Cell" cup the feed chamber and the reservoir have the same capacity, so that the cup may be screwed down as far as it will go, driving all the grease into the feed chamber, setting the indicator and at the same time jam-locking the cup to the base against jarring off. Both cups, which are manufactured by the Standard Manufacturing and Sales Co., 1325 Arch St., Philadelphia, Penn., have fiber washers to prevent leakage of grease, and in both the height of the indicator always tells the amount of grease in the feed chamber.



DUPLEX GREASE CUP

Methods of Synchronizing Alternating-Current Machines

By FRANK GILLOOLY

The construction and principles of operation of the different types of synchronoscopes are described and various methods of synchronizing alternating-current machines discussed.

BEFORE alternating-current generators may be paralleled, their frequencies must be the same and their voltages equal and in phase; in other words, they must be in synchronism. The same thing applies to large synchronous motors or converters—in fact, to any rotating synchronous apparatus that is not self-starting.

The earliest method used to determine the condition of synchronism was by connecting lamps in series between the machines being synchronized. The lamps were connected between like terminals of both machines, Fig. 1, if synchronizing was to be done with the lamps dark; and between opposite terminals, Fig. 2, for synchronizing with the lamps bright. The lamps in either case indicated by their degree of brilliance the voltage difference between the machines. The lamps on high-voltage machines are connected through potential transformers, with a set of lamps for each of two or three of the phases. In addition to synchronizing, the lamps are utilized for phasing out the alternators. The connection whereby the lamps are bright

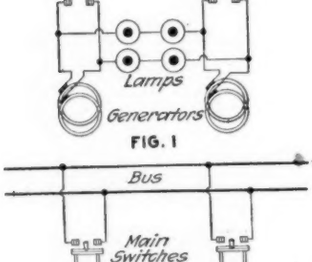


FIG. 1

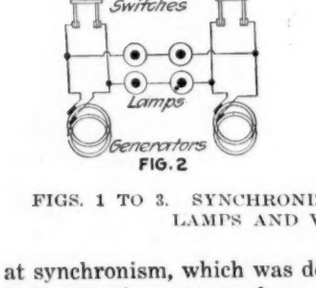


FIG. 2

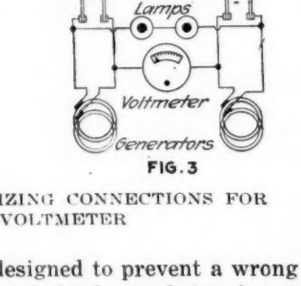


FIG. 3

FIGS. 1 TO 3. SYNCHRONIZING CONNECTIONS FOR LAMPS AND VOLTMETER

at synchronism, which was designed to prevent a wrong indication by reason of one of the lamps being burnt out, is now rarely used.

Lamps are unsatisfactory for synchronizing because they can do nothing more than to indicate a difference in voltage above that value required to glow their filaments. Voltmeters have been substituted for lamps, as in Fig. 3, but while they indicate any voltage difference, they do not show the relative speed of the machines or the phase angle between them. Only in the synchronoscope—synchronism indicator—are all these desirable features combined.

Whatever style of synchronoscope is used, the generator switch is closed when the synchronizing instrument's pointer is traveling slowly and is close to the zero. A more or less violent disturbance will be produced in the incoming and running machines if the switch is closed when the machines are not in synchronism, depending on how far the incoming machine is out of phase. This disturbance is slight if the switch is closed when the synchronoscope is rotating slowly in the "fast" direction and is approaching zero. The effect of closing the switch when the machine is "fast" and past the zero mark is to make it take a large percentage of the load, the amount of which will depend upon and be due to the machine's advance in phase angle over the running machines. If the incoming machine is "fast" but has not reached zero when the switch is closed, the other machines will easily pull it into step—a condition toward which it was moving. Should the incoming machine be running "slow" and the switch is closed when the synchronoscope pointer has passed zero, the disturbances will be heavy, since the other machines must reverse the direction of the former's phase angle in order to pull it into step. If the incoming machine is "slow" and approaching zero, the disturbance will not be so great, though more severe than if it had been rotating "fast." In each of these four cases a rush of synchronizing current will occur between the armatures of the machines until the incoming generator has been pulled into step. The effect of closing the switch with the incoming machine's voltage different from that of the bus is to cause armature cross-current to flow between the machines, due to the unequal fields.

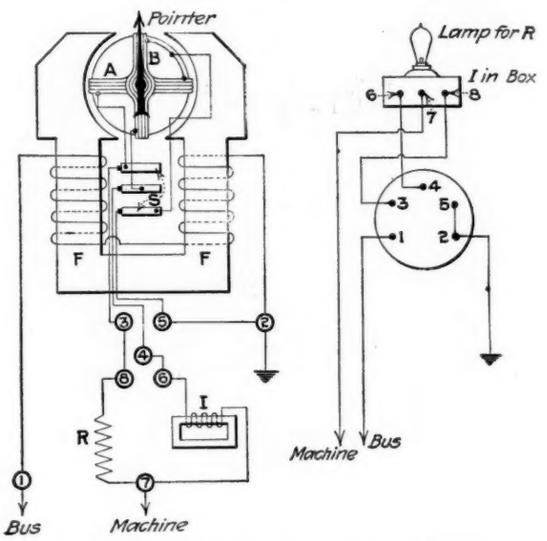


FIG. 4. SCHEMATIC DIAGRAM OF LINCOLN SYNCHRONOSCOPE

There are a number of makes of synchronoscopes, or synchronizers. The Lincoln type, manufactured by two different companies, operates on the rotating-field principle, the speed of the moving element representing the difference in frequency between the two circuits being synchronized. In the stationary position of the moving element, at any instant, the angle between its pointer and the zero point on the scale represents the phase angle between the two circuits.

The Lincoln synchronoscope, Fig. 4, is essentially a bipolar, split-phase, synchronous motor operating on the

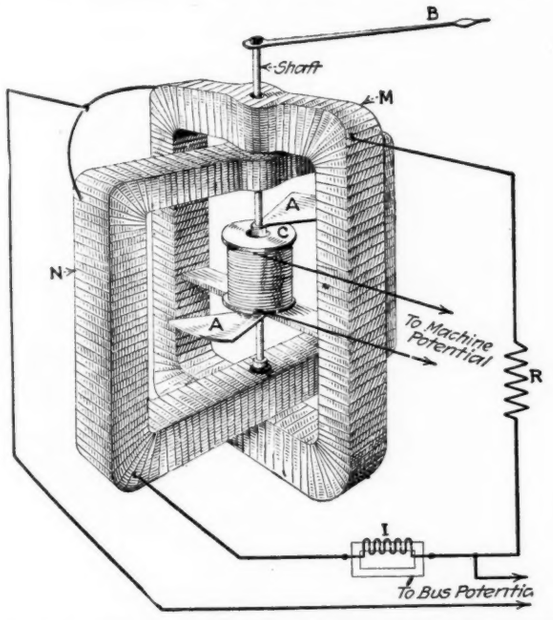


FIG. 5. SYNCHRONOSCOPE SIMILAR TO FIG. 4 BUT HAVING ALL COILS STATIONARY

difference in phase between the machines being synchronized. Its two field coils, F and F, are connected in series across one phase of the bus, or the running machine, consequently excited with alternating current instead of direct current. Its two armature coils, A and B, located at an angle of 90 deg. to each other, are connected in parallel through slip rings and brushes S to the corresponding phase of the incoming machine. The armature and field cores are of laminated iron.

One armature coil A has a resistance R in series with it, the other coil B has an inductance I in series with it; causing the current in B to lag behind the current in A by approximately 90 deg., thus producing a rotating field in the armature core which, when acted upon by the alternating field of the field circuit FF, causes the armature to assume the position where its lines of force coincide with those of the field. As this point changes the armature rotates with it. Since the current in the field coils lags the voltage across them by nearly 90 deg., and the current in the armature coil B, due to the inductance in series with it, lags the voltage across it by approximately 90 deg., at exact synchronism B will be in the position where its field will be parallel to the field of FF. This position of the armature at synchronism brings its pointer to the vertical position, as shown in Fig. 4, corresponding to the indication on a clock at the hour of twelve. The indicator rotates clockwise when the incoming machine is "fast" and counterclockwise when the incoming machine is "slow."

Another type of synchronoscope operating on the same principle is shown diagrammatically in Fig. 5. The moving element consists of two vanes, A and A, on either end of a cylindrical iron core in the center of the fixed coil C and fastened to the shaft carrying the pointer B. The rotating field is produced by the two stationary coils M and N situated 90 deg. apart and connected in parallel, M through a resistance R and N through an inductance I.

The vanes are excited alternately positive and negative by the alternating field of coil C and are deflected by the fields of coils M and N. Coil M has its current in phase with that of C and deflects the vanes so as to parallel the field of M with that of C. Coil N, with the inductance I in series, has its current lagging that of C by approximately 90 deg.; and so long as this phase relationship is maintained—which is the point of synchronism—it exerts no torque on A and A. At any other angle of phase between N and C, N will deflect the vanes; and with a difference in frequency between machine and bus a varying torque will be produced that will rotate the shaft.

In this instrument the rotating field is produced in the split-phase winding by the bus potential and the alternating field by the machine potential—an arrangement opposite to that of the Lincoln instrument, Fig. 4. Hence, the indicator's direction of rotation is counterclockwise when the incoming machine is "fast" and clockwise when the incoming machine is "slow."

The synchronoscope shown in Fig. 6 operates on the electrodynamometer principle, in which the torque exerted on a movable coil A, suspended between two stationary coils F and F, is opposed by spiral control springs. The stationary coils F and F are connected in series through the resistance R_F across the bus or running machine. The movable coil A, carrying the pointer, is connected in series with a condenser C and a resistance R_A, across the machine to be synchronized.

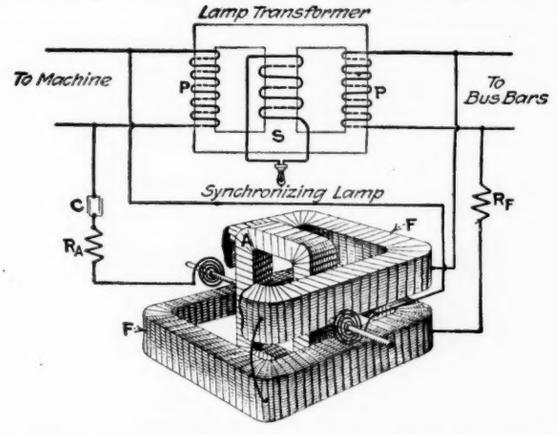


FIG. 6. SYNCHRONOSCOPE OPERATING ON THE ELECTRODYNAMOMETER PRINCIPLE

A 90-deg. phase displacement is thus obtained by making the current in A lead that in F and F by means of the condenser.

At exact synchronism—the true 90-deg. phase angle between the movable and stationary coil circuits—no torque is exerted on A, and it is held at zero position in the center of scale by the control springs. A difference in frequency between the machines will produce a varying torque, and A will oscillate the pointer back and forth on the scale. If the frequencies of machine and bus are equal but there is a difference in phase, A will take up a position of balance along the scale correspond-

ing to this phase angle. Right and left of the zero, central, position of the scale are "fast" and "slow" respectively with regard to the machine. The pointer merely oscillates back and forth on the horizontal scale instead of rotating over a circular dial. The dial is illuminated by one lamp connected to the secondary S

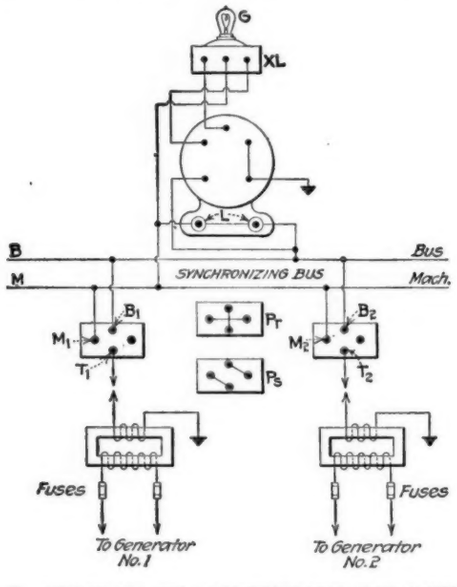


FIG. 7. DIAGRAM OF CONNECTIONS FOR LINCOLN SYNCHRONOSCOPE

of a transformer having two primaries P and P, connected one across the incoming machine and the other across the bus, and is bright at synchronism.

Each revolution of the synchronoscope pointer represents one cycle difference in frequency between the alternators. The deflection of the pointer from zero at any instant represents the phase angle between the machines. This last function of the synchronoscope is utilized in the paralleling of frequency changers, so that they may take their share of the load, after the two systems on which they run have been locked in step and speed regulation on the individual frequency changers is impossible. A separate synchronoscope is provided for both motor and generator of the set. The motor's switch is closed when its synchronoscope indicates zero and the generator's switch is closed when its synchronoscope indicates the advanced phase angle calculated to make the generator take up a specified amount of the load.

The foregoing requires fine synchronizing. The operator here has two synchronoscopes to watch. With a 60-cycle to 25-cycle frequency changer (the usual type) if the proper synchronizing point is missed the operator must wait twelve revolutions on the 60-cycle synchronoscope and five revolutions on the 25-cycle synchronoscope—the ratio in whole numbers of the two frequencies, 60 to 25, or 12 to 5—before the desired combination again appears. Charts are usually provided, showing the indications on both synchronoscopes one revolution before the motor switch is closed.

The synchronoscope is not intended to be kept energized when not in use or to be revolved at too great a speed. Where synchronizing lamps are provided, the speed of the alternator should be adjusted closely by them before the synchronoscope is plugged in circuit; if necessary, the synchronism indicator may be plugged in for a moment in order to determine whether the incoming machine is fast or slow. Just as the lamps can be checked against the synchronoscope when synchronizing, so should the instrument be checked against the lamps when phasing out apparatus. Suitable systems of plugs and receptacles permit of both operations, and through the phase-selector instrument switch, Fig. 8, likewise a part of the equipment of a modern switchboard, the synchronoscope can be connected in turn to both phases. Synchronoscope plugs now have an extra pair of contacts as shown at S_c in Fig. 8, through which the closing circuit of the remote-controlled oil switch is completed, in order to prevent the mistake of closing a wrong generator switch.

In Fig. 7 is shown a simple form of Lincoln synchronoscope installation that is frequently met with. The synchronizing bus runs to all generator panels. All receptacles are wired alike, to the same phase on each machine. One side of the generator potential transformers is grounded, the other sides are brought

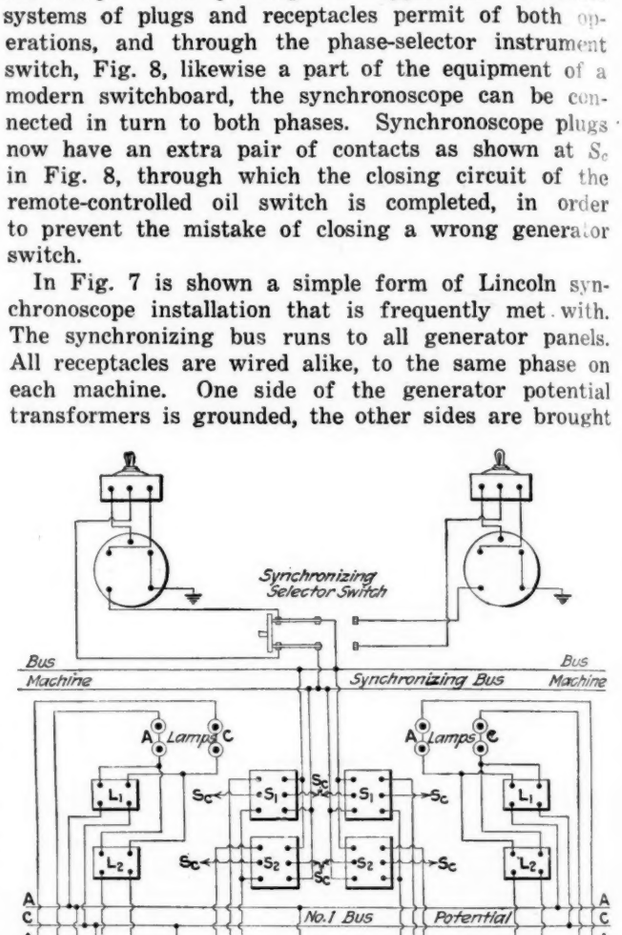


FIG. 8. DIAGRAM OF SYNCHRONIZING LAYOUT FOR A LARGE STATION

to the bottom terminals T_1 and T_2, of the receptacles. Two kinds of plugs are used: One, P_r, is inserted in the receptacle of the running machine, the other, P_s, in the receptacle of the incoming machine. The top connection, B_1 and B_2, of each receptacle goes to the conductor B of the synchronizing bus connected to the field coils of the synchronoscope. The third point of each receptacle, M_1 and M_2, goes to the conductor M of the bus connecting to the armature of the synchronoscope. The fourth terminal of the receptacle is not used with

grounded secondary transformers. The inductance-resistance box is shown at XL, of which lamp G is the resistance. Lamps L are on the base of the synchronoscope and are connected so as to be dark at synchronism.

Fig. 8 shows a typical synchronizing layout of a large station. Here two synchronoscopes are provided, made selective from a double-throw, double-pole knife switch. The synchronizing is done between machine and bus and can be from either phase through the double-throw phase-selector switch. Potential transformer connections are shown for both two- and three-phase, three-wire systems. Primary and secondary fuses are located with the transformers in the bus structure. The synchronizing and bus-potential busses go to all generator panels. Each generator panel has, in addition its own machine-potential bus, to which are connected the pilot lamps, the voltmeter and the potential coils of the wattmeters and the power-factor meter. The generator oil switches cannot be closed unless the synchronoscope plug is in the proper receptacle, as the direct-current supply circuit to the closing element of the switch is open between the middle pair of contacts of the receptacle, as shown at S_c on each receptacle.

Phasing lamps, A and C, are provided on two phases of each generator and have a separate receptacle to each bus, L_1 and L_2. As the station has duplicate busses, two synchronoscope receptacles, S_1 and S_2, are necessary. The lamps are plugged in circuit before the synchronoscope, and the frequency of the incoming unit is adjusted close to that of the bus by speeding or slowing until the rate of change in lamp brilliance is low.

Any apparatus may be phased against the alternators by closing it on the bus not in use and inserting the plug in the lamp receptacle to that bus from one of the alternators on the line. The synchronoscope is checked against the lamps by plugging it in on the generator connected to the bus carrying the apparatus being tested, and both phases are thus checked by throwing over the instrument phase-selector switch. In large systems new high-tension apparatus is never put on the line until this phase-test has been made on it. Duplicate bus systems are now in use in all stations and substations of modern central-station systems.

Refrigerating Troubles in a Packing House Plant

By J. C. MORAN

Because of inadequate cooling coil surface chiefly, the plant of a packing house gave the crew no end of trouble. How the plant was put in good condition, paying the cost in six months on the saving in coal and water, is told in the article.

IT SEEMS peculiar, but it is a fact, that the average packing-house power plant is run "on a shoe string." Often it is a case of getting one piece of equipment fixed up at the moment another breaks down. Something is always going to wreck or refusing to work properly. Sometimes several machines go out of commission at once and then the whole works is tied up until a makeshift repair is made; generally the equipment is left in this condition until it lets go again. Consequently the average packing-house power-plant force is always on a hot stove or going to a fire, as it were. The particular plant in question was no exception to the general rule, and as is nearly always the case, the management had insisted on the cheapest possible installation when it was first built and refused to make any improvements until the service became so bad that something had to be done. This attitude on the part of packing-plant owners may be due to there being so much more greater returns on the money when invested in the manufacturing end of the business than the more moderate savings made by keeping the power plant up-to-date.

The plant was a little over two years old. They managed to pull through the second season without spoiling too much of the meat in the coolers; but during the winter business increased considerably and in the latter part of March it was impossible to keep the temperatures down with the machines running at top speed. It required no prophet to predict what would happen when the weather became warmer. It was at this time that the writer was called in.

The refrigerating equipment consisted of three horizontal double-acting compressors, atmospheric condensers, and direct expansion coils in all the rooms. The load came from two large chill rooms, two large storage coolers, a wholesale market of considerable size, three freezers and an offal cooler. The machines were of 40, 75 and 125 tons respectively and ran at 80 to 95 r.p.m.

The largest machine has been run only one season, having been installed when it was found that the other two could not carry the load. No more pipe had been added

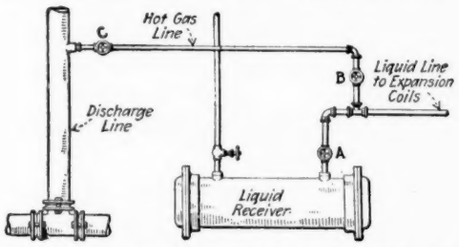


FIG. 1. HOT GAS CONNECTION TO DISCHARGE LINE

in the coolers, however, and when I came to check over this part of the equipment I began to understand why it was necessary to run the machines at this high speed to get the work done. To liberally provide the rooms there should be about three times more pipe. A liberal amount of piping is about one of the best investments that can be put into a refrigerating system.

Nor was this all. About a gallon of oil went into the system every day, and the oil traps were blown about every two weeks. As a consequence the traps ran over most of the time and the system was loaded with oil. In addition, the frost had apparently never been removed from a number of the coils.

The first move was to order 40,000 ft. of 2-in. pipe for additional coils in the various rooms. The next was to make a hot gas connection from the discharge line of one of the compressors to the liquid line from the liquid receiver to the expansion coils. The connections are illustrated in Fig. 1. By this connection it was possible to turn hot gas direct from the discharge line

into the expansion coils. By shutting off the valve on the suction end of the coils and opening the liquid or expansion valve wide this hot gas passed direct from the discharge line through valves *C* and *B* and the expansion valve at the coil directly into the same, where it began to condense and heat the coil, just as in a condenser, except that heat was taken up by the frost on the coil. While operating in this manner, the valve *A* had to be closed; the other coils supplied from this liquid line had to have their expansion valve shut off, with the exception of the one being cleaned.

This loosened the frost on the coils and in about three days every coil was clean. Now we could slow the machines a little and still hold the temperatures. Of course the outside temperature was not very high, still it was warmer than it had been the week previous when all the machines had been run at top speed, and yet the cooler temperatures had been 15 to 20 deg. F. too high. We drew off from the traps more than a large pailful of oil every day. No oil was used except on the lanterns in the stuffing-boxes.

The greatest trouble was experienced in the chill rooms for the beeves and hogs. I don't remember the keep the sharp freezer at about 10 deg. We had to run at a lower pressure at times to keep the temperature in this cooler to 10 deg. or lower. The superintendent wanted it kept at zero or lower, but when shown how much coal it would cost he agreed to let it go if I would promise to improve conditions later on. The net result was that a large portion of the coils in the chill rooms and storage coolers were out of service part of the time and this did not tend to the most economical operation.

After figuring on the problems for some time I finally suggested installing an additional suction line to connect to the freezers with a cross-connection to the wholesale market cooler and the two storage coolers, as shown in Fig. 2, which was done. We left the 40 ton machine on the three freezers and cut the suction pressure to about 10 lb. At this suction pressure it was possible to keep the sharp freezer at zero to 5 deg. below, while the others were easily carried at 15 to 20 deg. The machine handled the load nicely at a speed of about 55 r.p.m., leaving plenty capacity to spare for hot weather.

On the rest of the system we were able to handle the load the greater part of the time with 28 to 30 lb.

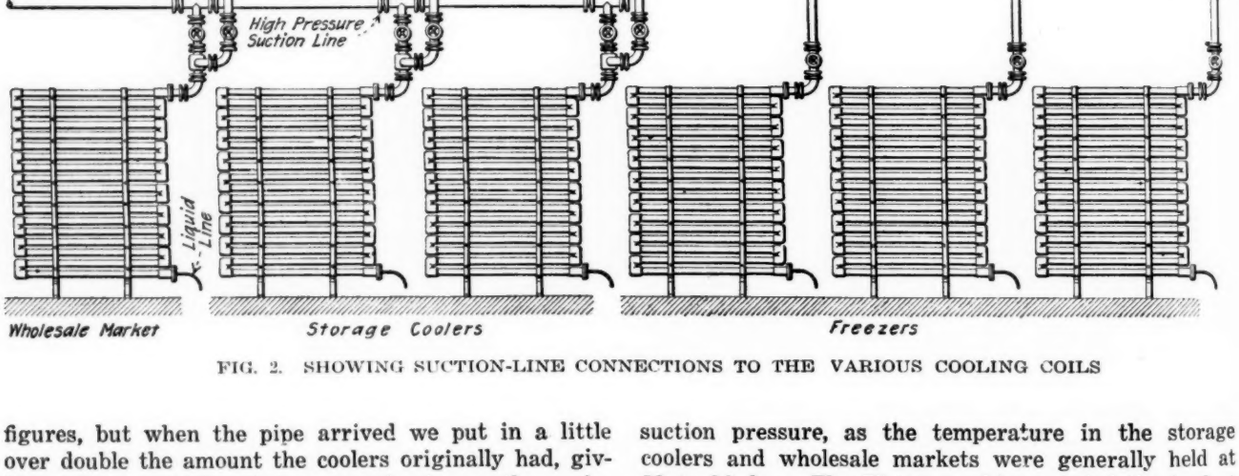


FIG. 2. SHOWING SUCTION-LINE CONNECTIONS TO THE VARIOUS COOLING COILS

figures, but when the pipe arrived we put in a little over double the amount the coolers originally had, giving them over three times as much pipe as they originally contained. While this gave a liberal amount, it was not high as compared with the best practice.

When these new coils were cut in the chill room temperatures came rapidly down. To show what they would do I arranged the work so that we cut them all in one Saturday night. Sunday and Sunday night a gang was working with air and a steam hose to thoroughly blow the oil out of the old coils. Monday afternoon everything was cut in and towards evening when the coolers had a full load, everything was working fine. About 1.00 a. m. Tuesday the beef cooler had come down to 34 deg. and the hog cooler to about the same, which was really too fast work for pork, and the engineer cut out coils one after the other until he had only half of them working. He was about the most tickled man in town. So were the owners the next morning.

The rest of the coolers and freezers were similarly provided and made it possible to carry the load most of the time with the 40 and 75 ton machines. The suction pressure had jumped from zero to 18 lb.; it would have been considerably higher, but it had to be kept there to suction pressure, as the temperature in the storage coolers and wholesale markets were generally held at 33 to 36 deg. The 75-ton machine carried the load at a speed of 55 to 60 r.p.m. In case it was desired to pull down any one of the storage coolers or the wholesale market in a hurry it was necessary only to switch it over to the low-pressure system.

This proved particularly advantageous in case there was a heavy load in the chill rooms at night. The wholesale market, and sometimes one of the storage coolers, was then switched over to the low pressure system and just enough coils used to slowly bring down the temperature. The speed of the other machine would then be increased to maximum. Soon the rest of the rooms would also be cool and from then on it was necessary only to run the machines at normal speed to hold the temperatures. Bringing the temperatures down during the first part of the night's run is the packing house engineer's hardest job, but by this arrangement he can do so without difficulty.

When I first came on the job the condenser pressure was somewhere around 200 lb. By purging the pressure came down to 135 lb. It was now possible to leave the 125-ton machine out of service until very

warm weather. So we gave it a thorough overhauling. During the hot weather it was possible to carry a greatly increased load with the 75-ton machine running on the low pressure system and carrying the wholesale market all the time and the 125-ton machine carrying the high pressure part of the system, both machines running not over 60 r.p.m.

When the machines were all gone over we tackled the condenser and cut out one stand at a time, disconnected it at both ends and gave it a thorough blowing out, first with steam and then with air and removed all the scale on the outside of the pipes. When this job was finished we had about three barrels of oil and dirt. In addition to the work on the refrigerating system I suggested a hot water tank in which nearly all the hot water used in the plant was heated by exhaust steam and in addition we arranged for the use of exhaust steam in a number of other places around the plant. When we got through the coal consumption had been cut nearly in half. At any rate where they had before pushed three boilers to the limit they were now able to hold the pressure easily at any time with two boilers.

Boiler- and Engine-Room Record Sheets

BY P. R. DUFFEY

MOST engineers are interested in power-plant record sheets, and the accompanying illustrations are reproductions of some that have proved their worth. The last sheet in Fig. 2, was made up to cover the needs of a weekly boiler-room record from several fired plant. The boilers are of the water-tube type, and the grates used are of the locomotive shaking type with the dumps located at the bridge-wall and at the deadplate. This type of grate has large air space between the grates and is well adapted to burning

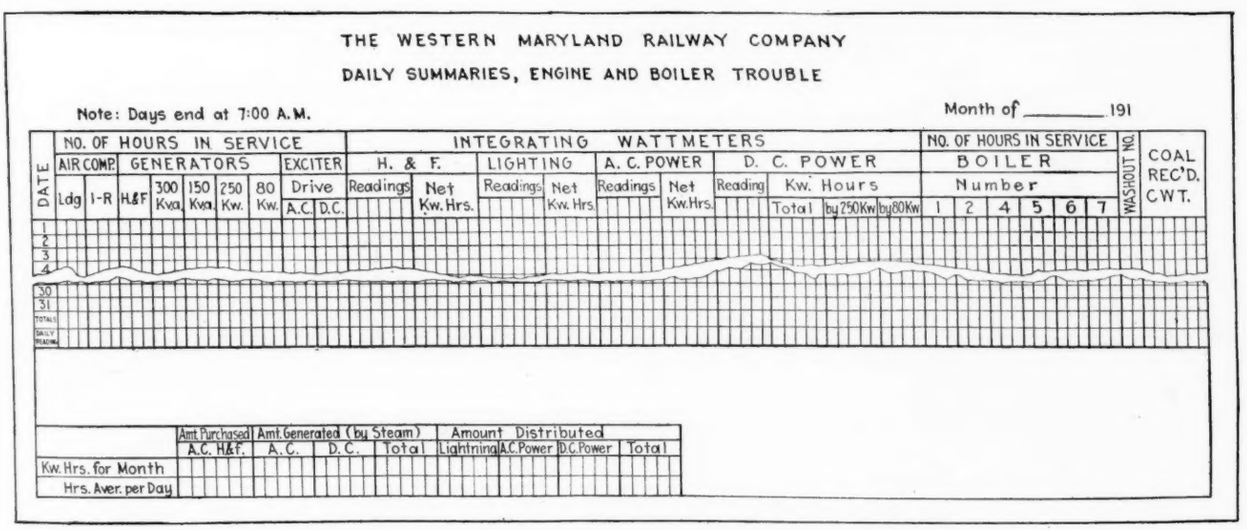


FIG. 1. DAILY LOG OF POWER PLANT, BOTH STEAM AND ELECTRICAL

plants, located in a district covering a radius of 150 miles from headquarters, and reporting to the main organization. Hence a standard form was necessary to cover the general conditions of all plants, and a study of the record will show that this is in evidence. The center sheet shown was made up to cover the needs of a weekly check on operating expenses at each plant, and of the supplies issued.

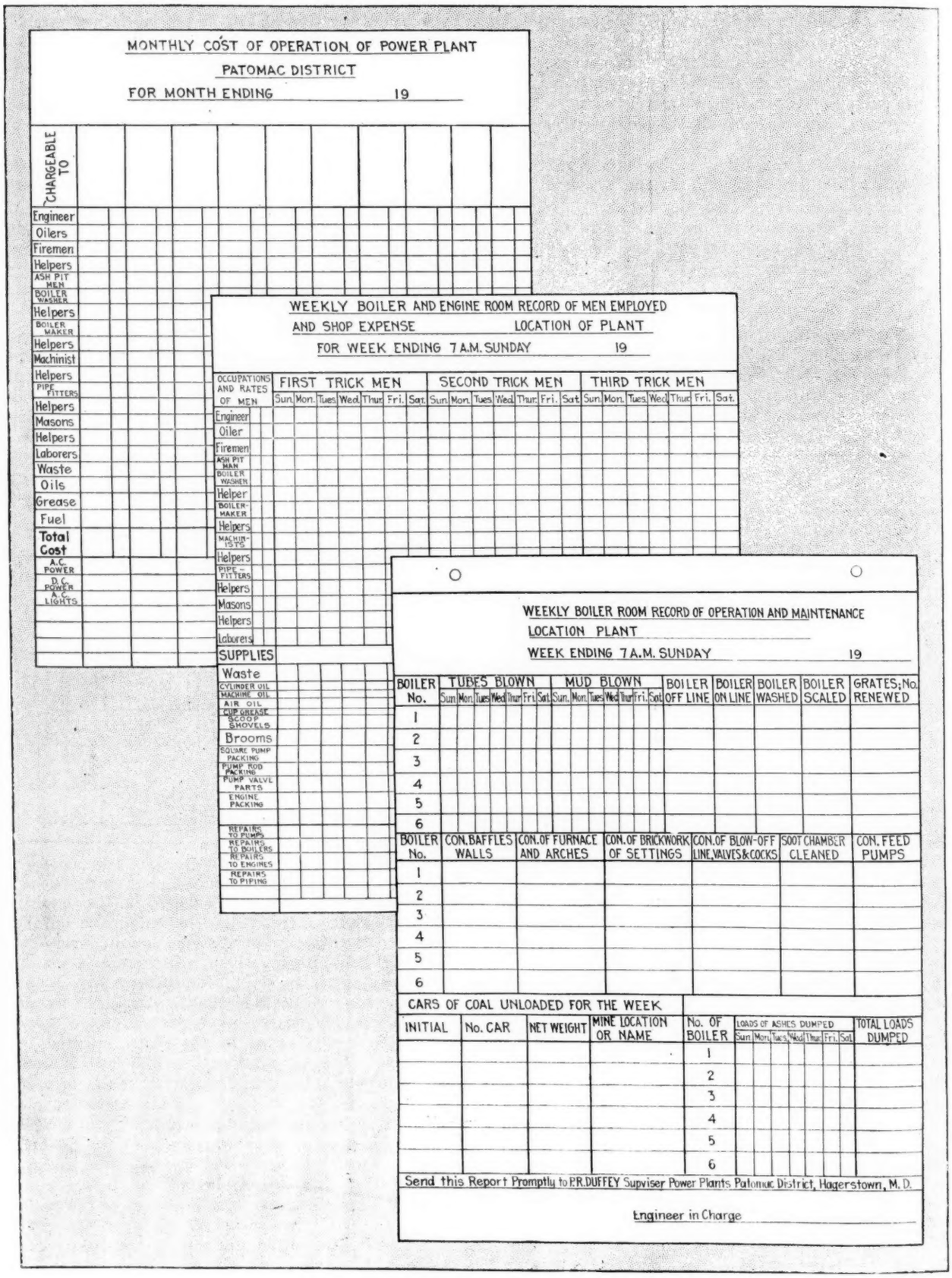
The monthly cost sheet, Fig. 2, was made up to compile the monthly costs of the various plants and the information obtained from the No. 1 and No. 2 records is used for this purpose. The total kilowatts of power generated is obtained from the record sheet, Fig. 1, and this sheet is used only at plants where electric power is generated or a more elaborate statement than record No. 1 is desired.

The information obtained from these records is giving very satisfactory results and is accurate when the parties in charge give the necessary attention to the work required in making out the record. The recording charts shown in Fig. 3 are from hand-fired plants. One chart is an average sample from a hand-

the grades of run-of-mine soft coal used in the locality where this plant is situated. The outer line on the first chart shows the steam pressure and an inner line records the air pressure, which will show at a glance how the two pressures run. This is necessary in the plant where the recorder is located, as operation depends as much on good air pressure as on steam pressure.

The firing method used at the plant referred to is done alternately by hand, and as the load is very irregular, it is hard to maintain an average CO_2 of over 10 per cent. for the 24 hours. An average sample is collected in an automatic gas-collecting tank, and an analysis is made once in 12 hours. At times when the load is reasonably heavy for a long period, a percentage of 12 CO_2 has been obtained on a 4-hr. run. The firemen have been instructed in the use of the draft gage, and with a frequent check on operation coal consumption is kept to the minimum, yet at best there is waste which under present conditions cannot be overcome. The solution would be a stoker installation.

The top right-hand chart shows the temperature of the feed water entering the boiler and also that of



MONTHLY COST OF OPERATION OF POWER PLANT

PATOMAC DISTRICT

FOR MONTH ENDING 19

CHARGEABLE TO											
Engineer											
Oilers											
Firemen											
Helpers											
ASH PIT MEN											
BOILER WASHER											
Helpers											
BOILER MAKER											
Helpers											
Machinist											
Helpers											
PIPE FITTERS											
Helpers											
Masons											
Helpers											
Laborers											
Waste											
Oils											
Grease											
Fuel											
Total Cost											
A.C. POWER											
D.C. POWER											
A.C. LIGHTS											

WEEKLY BOILER AND ENGINE ROOM RECORD OF MEN EMPLOYED AND SHOP EXPENSE LOCATION OF PLANT

FOR WEEK ENDING 7 A.M. SUNDAY 19

OCCUPATIONS AND RATES OF MEN	FIRST TRICK MEN							SECOND TRICK MEN							THIRD TRICK MEN						
	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
Engineer																					
Oiler																					
Firemen																					
ASH PIT MAN																					
BOILER WASHER																					
Helper																					
BOILER-MAKER																					
Helpers																					
MACHINISTS																					
Helpers																					
PIPE FITTERS																					
Helpers																					
Masons																					
Helpers																					
Laborers																					

SUPPLIES	
Waste	
CYLINDER OIL	
MACHINE OIL	
AIR OIL	
CUP GREASE SCOOP SHOVELS	
Brooms	
SQUARE PUMP PACKING	
PUMP ROD PACKING	
PUMP VALVE PARTS	
ENGINE PACKING	
REPAIRS TO PUMPS	
REPAIRS TO BOILERS	
REPAIRS TO ENGINES	
REPAIRS TO PIPING	

WEEKLY BOILER ROOM RECORD OF OPERATION AND MAINTENANCE

LOCATION PLANT

WEEK ENDING 7 A.M. SUNDAY 19

BOILER No.	TUBES BLOWN							MUD BLOWN							BOILER OFF LINE	BOILER ON LINE	BOILER WASHED	BOILER SCALED	GRATES; No. RENEWED
	Sun	Mon.	Tues	Wed	Thur	Fri	Sat.	Sun.	Mon.	Tues	Wed	Thur	Fri.	Sat.					
1																			
2																			
3																			
4																			
5																			
6																			

BOILER No.	CON. BAFFLES WALLS	CON. OF FURNACE AND ARCHES	CON. OF BRICKWORK OF SETTINGS	CON. OF BLOW-OFF LINE, VALVES & COCKS	SOOT CHAMBER CLEANED	CON. FEED PUMPS
1						
2						
3						
4						
5						
6						

CARS OF COAL UNLOADED FOR THE WEEK

INITIAL	No. CAR	NET WEIGHT	MINE LOCATION OR NAME

No. OF BOILER	LOADS OF ASHES DUMPED Sun	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	TOTAL LOADS DUMPED
1								
2								
3								
4								
5								
6								

Send this Report Promptly to P.R. DUFFEY Supviser Power Plants Patomac District, Hagerstown, M. D.

Engineer in Charge

FIG. 2. THREE RECORD SHEETS THAT HAVE PROVED THEIR WORTH

the feed-water heater. A constant line indicates the temperature of the water entering the boilers from the heater. A variable line indicates the temperature of the water entering the heater. The many rises of this line indicate the number of times the water-inlet valve closed during the day's run, showing further that the heater is not being worked to full capacity at any time, otherwise the inlet valve would remain open practically is now placed in the steam line to record the temperature of the steam being delivered.

The remaining three charts are taken from the operation of a hand-fired plant having a constant load and using river anthracite culm as fuel. One chart shows a record of steam pressure, another the record of feed-water temperature, and the center one shows a record of the air pressure.

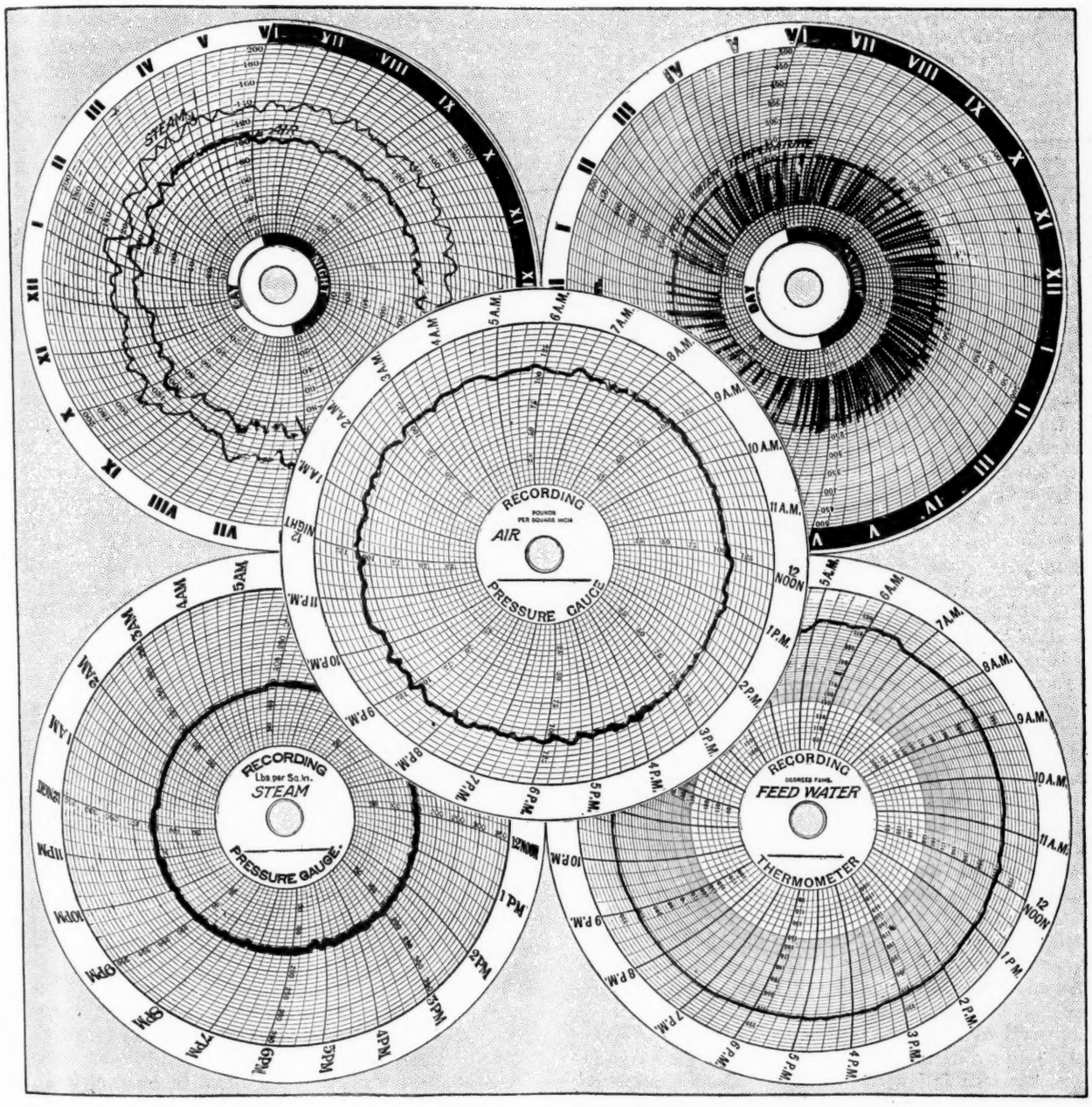


FIG. 3. CHARTS FROM RECORDING INSTRUMENTS IN A HAND-FIRED PLANT

the entire period. Further, it will be seen that the temperature recorded when the valve is closed is several degrees above that of the water entering the boilers. This is due to the fact that the exhaust steam coming in contact with a diminished water supply heats very rapidly the small supply of water entering the heater through the bypass on the inlet line. This check has been discontinued, and the thermometer bulb

A system of shaking and dumping grates and forced draft is employed to burn this fuel, as well as combustion arches in the furnace for igniting the fuel. This fuel runs very high in moisture and ash, and the temperature required for ignition is high. Where the cost of such fuel is low and transportation charges low, it is economical to burn, otherwise the gains thus obtained would be offset by a loss.

Experiments on Stack Performance

By JULIAN C. SMALLWOOD

The purpose of the investigation to be described here is to compare experimentally determined temperatures, velocities and pressures in a stack with the values assumed and the results calculated in design. From such a comparison, with complete data, can be deduced values of friction losses in stacks, concerning which there is practically little known.

HEIGHT and area are the two most important quantities to be found in chimney design. To calculate the height necessary for a required draft, one must make certain assumptions, the most inexact being that of stack-gas temperature. Given a knowledge of this variable quantity, one could figure the necessary stack height with precision, provided friction losses are kept low. It is probable that these losses follow the general laws governing fluids and vary with the square of the velocity. Consequently, if stack-gas velocity is low friction loss is negligible, and the actual draft closely approximates that calculated from the theoretical formula, provided the correct stack-gas temperature is inserted. To keep the velocity as low as this, however, means that the cross-sectional area of the stack must be prohibitively large. For economy in construction this area should be as small as may be without increasing the velocity and resulting friction losses to such an extent as to diminish greatly the available draft. The usual method of proportioning stacks is to calculate the height from an assumed temperature at the base, which is probably always much higher than the average temperature of the whole column, and to make a generous allowance for this inexactitude and to cover friction losses. The area is then obtained by an empirical formula, such as Kent's, depending upon examples in practice. It is reasonably certain, however, that in ordinary practice the stack carries much more air than passes through the furnace, because of infiltration through idle boilers, clean-out doors, leaky joints between metal and brick, and other defects in metal and brickwork. The formula thus yields larger stack areas than would be necessary if such imperfections were eliminated. At all events the whole method is unscientific and inexact.

An admirable advance from this rule-of-thumb procedure has been suggested by A. L. Menzin (Vol. 37, "Transactions American Society Mechanical Engineers") in a rational method of stack design. The advance, however, is largely mathematical, as he presents no method of arriving at the true density of the stack gases (that is, of estimating their temperature), uses values of friction coefficient based on old and limited experiments, and does not state how he has selected his table of "economical gas velocities."

The questions, then, first to be answered before an exact method of stack design can be put into effect are:

What are the average temperatures of gases in stacks of different types, corresponding to initial temperatures at their bases?

How does the loss of draft pressure, due to friction, vary with stack-gas velocity?

It should be stated at the outset that these two questions were not satisfactorily answered in the present investigation for the following reasons: First, an answer to the question regarding temperature, to be of general applicability, should be based on data from numerous stacks under all the variable conditions of operation, whereas only one stack was available and that only during the cold months. Second, because the equipment was not, and probably will not be for an indefinite time, operated at anywhere near its rated capacity, the stack-gas velocity was very low, making the friction losses too small to be accurately measured. On the other hand, certain methods of measurement were decided upon and certain others eliminated as inappropriate, a good deal of preliminary work was done, and some significant measurements were made. Therefore, as a guidance to other investigators of the same subject and as a matter of interest to others, it has been thought worth while to describe the present work, incomplete as it may be.

The experiments were made on the stack at Johns Hopkins University, which stack takes care of four boilers rated at 1000 hp. The design is a Custodis, hexagonal, brick. It is 8 ft. 9 in. across the inside section at the bottom, and tapers to 7 ft. inside at the top, and is about 150 ft. high from the ground. The thickness of the walls is 27.5 in. at the base, 17 in. just above the firebrick, and 9 in. at the top. The firebrick lining, with 2 in. air space extends 50 ft. from the plane of the bottom of the breeching, which plane is taken as a datum. The breeching is 8 ft. high by 5 ft. wide.

There are two landings or platforms encircling the stack at distances of 33 and 55 ft. above the datum plane. At each landing there are eight 2-in. capped pipe openings for the insertion of pitot tubes, draft-gage connections, thermocouples, etc. These openings are on horizontal median lines at right angles.

Underneath the stack proper is built an instrument room in which the measuring instruments were set up. Draft gage and thermocouple connections were led here from the two landings, the top of the stack, and from the breeching.

Fig. 1 is a diagrammatic arrangement of the equipment.

It is perhaps best, now, to relate the considerations influencing the selection of instruments.

Draft Pressure and Temperature Measurements

For measuring pressures the inclined U-tube was used, of the form adopted by William Rowse in his experiments upon pitot tubes (Vol. 35, "Transactions A. S. M. E."). This draft gage is 5 ft. long, of large-bore tubing, and can be set at any desired small angle with the horizontal so as to make a large motion of the liquid level. The liquid was gasoline or kerosene. Two gages were used having been previously calibrated against a micrometer point gage precise to 0.001 in. It was found by repeated calibrations that the U-tubes were accurate and could be read to 0.002 in. This was satisfactory in so far as draft pressures were concerned, but not so in connection with the pitot tubes.

The familiar Ellison draft gage can be read to 0.005 in., and is more convenient to read. Where this is sufficient precision, this gage is therefore preferable.

The original idea of measuring the temperature within the stack was to use an electric resistance thermometer, fitting as closely as possible the entire stack cross-section, and to arrange this thermometer to be pulled from bottom to top. This would give an average temperature reading at any desired plane, but had the disadvantage that it made impossible simultaneous readings. Such a thermometer was actually constructed of fine nickel wire and carefully calibrated. It was found, however, that the stack gases changed the electric resistance of the nickel, this effect probably being due to a chemical action between carbon monoxide and nickel. Various alloys and materials made into wire were then tested with the purpose of finding one that would not be attacked and changed in electrical resistance by the stack gases. All showed an increase of resistance when allowed to remain in the stack from one to five days. It is possible that a solution of this problem lies in a sheathed resistance.

Failing with this type of thermometer, thermocouples were resorted to. The materials were copper and copper-constantin. After weeks of exposure to the hot gases they were found to be as accurate as when first introduced into the stack. As it was desired to insert them as far as the middle of the stack in a horizontal position (that is, about five feet from the outside wall), they were incased for stiffness, in light ¾-in. brass tubes 6 ft. long. The couple wires were insulated from it and each other by inclosing each in a one-length glass tube. Thus the brass tube inclosed the two glass tubes side by side, and the hot junction was allowed to project about an inch from the brass casing.

By means of these instruments and a four-point switch quick definite readings were taken with a millivoltmeter, of temperatures at the top, top landing, bottom landing, and in breeching, in less than a minute. (See Fig. 1 for these locations.) By introducing two couples at opposite openings on one landing, readings could be made across the stack and temperatures at various points compared with that at the center.

After calibration the couples were found accurate to within 5 deg. F.

The main objection to this arrangement (as shown at Fig. 1) was that although the readings at all four points could be taken practically simultaneously (that is, within one minute) they applied only to one point at each plane. Later readings showed that the temperature across the stack at one plane varied considerably, undoubtedly because of stratification of the gases. An improvement on the arrangement would be to have at least four couples at each plane, so arranged as to yield an average temperature. Recording apparatus would be suitable, both to get continuous records and to reduce the number of observers.

Velocity Measurement

Pitot tubes were tried for velocity measurement, the differential gages being of the form used for draft-pressure measurement, previously described. But, because of the low velocities prevailing, the velocity head was too small to be read with these gages.

Stack-gas velocities are generally between 5 and 40 ft. per sec., corresponding with velocity heads of 0.004 and 0.12 in. of water, respectively. During the experiments under discussion, values near the lower limit were realized. As the gages could not be read closer than 0.002 in., it was impossible to measure the velocity head with precison or to study its variation. Even with the higher velocities this would not be close enough. It was therefore attempted to make a more sensitive differential gage but without success, although numerous expedients were tried. It is very questionable, at all events, that the pitot tube is reliable at these low velocity heads.

Other instruments were considered and tried, such as the hot-wire anemometer and impact vanes. The latter, at first, promised a solution of the problem. A round vane on the end of a lever was placed in a current of air with its plane perpendicular to the flow. It was planned to measure the impact on this vane by weighing, a knowledge of which would make possible the calculation of velocity. It developed, however, that a low-velocity air current impinging against such a vane is attended

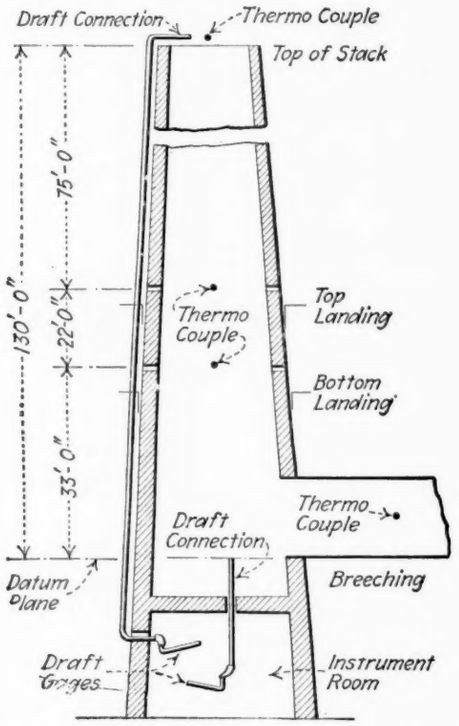


FIG. 1. DIAGRAM OF STACK AND EQUIPMENT

by eddies which cause a pulsation and a great variation on the weighing apparatus and prevent a close reading of the average impact.

The problem of measuring small velocities in a stack is still open for solution. It is highly desirable to measure not only average, but local velocities at any point or plane. There is much evidence to show that stack-gas flow is very irregular; in our present ignorance of the controlling laws it might even be termed capricious. There are many eddies, local accelerations, and even down-drafts. For a complete analysis of what takes place in a chimney it is necessary to measure these in extent and direction, and until some method of doing so is perfected, chimney design and construction will remain imperfect.

In the present investigation stack-gas analyses were occasionally made with the purpose of finding the amount of air leakage beyond the boiler.

Variation of temperature at one cross-section was found by comparing readings from two couples at one landing, one located with its hot junction at the center

of the stack and the other at successive positions one foot apart from one wall to the opposite. The two couples checked at the center, but the traversing couple showed on some days higher temperatures on the east side than on the west, and on other days just the reverse. A higher temperature at the center than on the sides was in no case realized. The maximum variation from center to side was ten degrees. It was concluded that the observed variation was due to the stratification of the stream of chimney gases.

Similar tests were made by traversing a vertical section of the breeching. The greatest variation was 20 deg., but in most cases it was from 5 to 10 deg. The variation was irregular, sometimes being hotter at the bottom and sometimes at the top, depending largely upon damper opening.

The most important readings were those giving the temperature gradient from top to bottom of stack. For

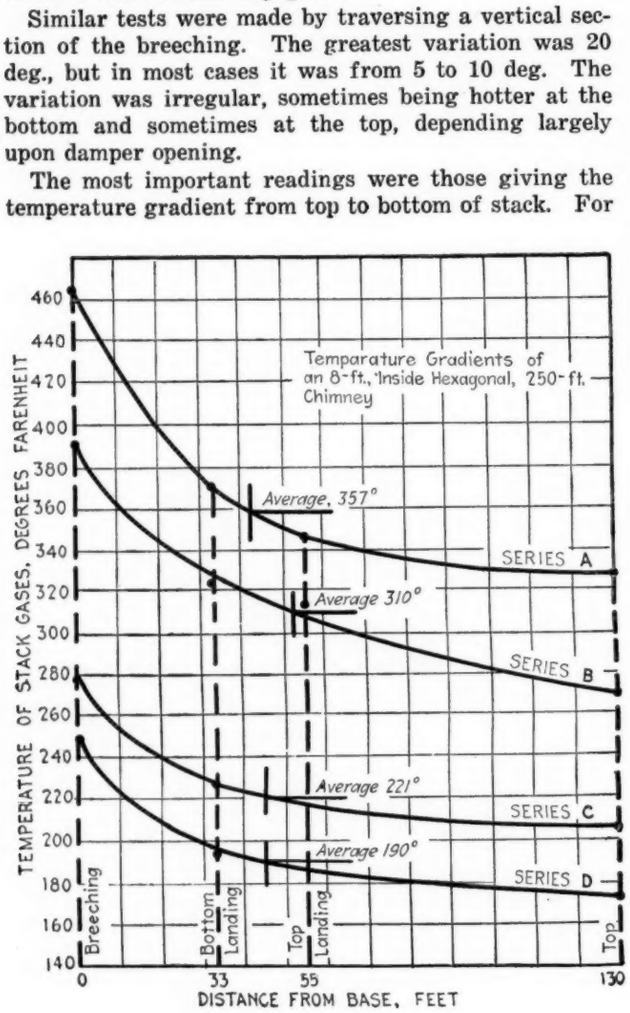


FIG. 2. TEMPERATURE GRADIENTS

each series of such readings draft pressures were also noted at each of the points indicated on Fig. 1. The accompanying table presents some of the results, drafts at the landings being omitted. The quantities in each series in this table are averages of at least three sets of observations under practically the same conditions.

The draft pressure at the top of the stack is due either to the column of hot gases rising above the stack or to the aspirating effect of the wind. This value subtracted from the draft at the bottom gives the actual draft pressure due to 130 ft. of stack with gases at an average temperature as given under each series. This average is found by plotting the temperatures as shown by Fig. 2 and determining the average height of the curve by planimeter.

The last item given in the table is the ideal draft pressure as obtained by the theoretical formula, without allowing for friction losses. The difference between the ideal and corresponding actual draft, it was expected, would disclose values of the friction losses, but owing to the low velocities and consequent small friction heads, these values could not be measured with precision, and in fact with some of the readings gave slightly negative results.

Analyses of the gases at the base of the stack showed the CO_2 in every case to be less than 5 per cent. as compared with 10 per cent. and over at the last pass of the boilers. It should be explained that the breeching received the uptakes from four 250-hp. boilers and one independently fired superheater. Only two of these boilers were in service and generally not to capacity. The superheater was idle. Consequently, there was ample opportunity for air leakage through these idle units. Every precaution was taken to avoid such leakage, even to the calking of dampers and clean-out doors, but there was a large leakage, particularly through the stokers, as was evidenced by a torch as well as by the gas analysis. Some of the excess air was undoubtedly due to leakage at the joint between breeching and stack, making a steeper temperature gradient between breeching and bottom landing than would be obtained by radiation alone.

Result of Air Dilution

The chief result of the air dilution was to make much lower initial stack-gas temperatures than are usually assumed. Series *A* and *D*, in the table and curves, Fig. 2, give the highest and lowest temperatures found. That the gas in the breeching is lower in temperature than the boiler steam is due, of course, to the cooling effect of the air leaking through the idle units. In this case the lowered stack-gas temperatures and consequently reduced draft did not affect the facility of boiler operation, since the plant is supplied with forced draft, a balanced system being in use. One cannot but be impressed, however, by the very considerable result of idle boilers to lessen the effectiveness of a stack. Even with the tightest sort of setting it is practically impossible to eliminate air leakage through an idle boiler.

An inspection of Fig. 2 is interesting. It is seen that the greatest fall in temperature of the gases in their ascent of the stack is 155 deg. and that the lower the

TEMPERATURES AND DRAFT PRESSURES

Series	A	B	C	D
Temperatures, deg. F.:				
Breeching	464	390	277	249
Bottom landing	370	324	226	194
Top landing	346	313	.....	.....
Top	328	270	206	173
Average from curve	357	310	221	190
Outside air	40	38	43	24
Pressures, inches:				
Barometer	30.06	30.00	29.63	30.27
Draft, bottom	0.772	0.6[illegible]	0.518	0.555
Draft, top	0.038	0.032	0.048	0.05
Draft, for 130 ft.	0.734	0.665	0.470	0.500
Calculated draft for 130 ft	0.752	0.685	0.492	0.504

average temperature the less the cooling during ascent. An exception to this is seen in the lowest curve, which has five degrees less cooling than *C*, just above it, but this is undoubtedly because the day was colder.

It seems difficult to believe that in the 15 to 25 sec. duration of passage in the stack the gases should cool to such an extent, especially when the thickness of the wall and the size of the inside cross-section are considered. Yet these results are assuredly valid. The only similar test results extant, to the writer's knowledge, are the ones made under the supervision of Prof. E. F. Miller at the Massachusetts Institute of Tech-

nology. A brief account of this work, with temperature gradients, was published in *Power*, Mar. 31, 1914, p. 461. It appears from their curves that the fall in temperature of gases in an 18-ft. internal diameter, 3 ft. thick at the base, was 80 deg. after a travel of 130 ft., the initial temperature being 480 deg. This compares favorably with series *A* in the present article. The 18-ft. stack was 250 ft. in height, and the gases cooled an additional 20 deg. from the 130-ft. level to the top, making the upper half comparatively ineffective, since the average temperature there was thus roughly 390 deg. The article referred to also shows that a 3-ft. square stack 102 ft. high, almost completely inclosed in a building at 70 deg., allowed a temperature fall of 175 deg., the initial being 440. From these figures and the data of the accompanying table it appears that the reduction of temperature through radiation from the stack is markedly less with the larger cross-sections. It is hardly needful to mention that this is in accordance with the fundamental principles of radiation.

It follows from the experimental results discussed that it is highly irrational to assume that the average temperature of the hot column is that at the base, as is done in design and in the formulation of tables of chimney drafts. A logical inference, too, is that the cooling may become so pronounced with high chimneys that their upper parts may be a hindrance instead of a help. With high stack-gas velocities, the friction losses of the upper part might easily exceed the theoretical draft pressure produced by this cool upper portion. Finally, it seems certain that, except in the most refined design and operation such as prevail at some large central stations, leakage of air lessens both the draft pressure and the boiler horsepower which can be accommodated, and if this could be eliminated, both height and area could be reduced without reducing the draft or capacity.

Acknowledgment must be made to Prof. Carl C. Thomas, who inspired the work of this investigation at Johns Hopkins University and to M. X. Wilberding, who began the experiments and with the writer carried them along.

Dismantling a Large Motor

By H. Wilson

If there is one thing that the electrical repairman is more familiar with than anything else it is hurry up jobs. The importance of electric motors in most industries today makes it very essential that they be kept in operation; therefore if one fails it means hurry up and get it back into service or install a spare machine. Recently I had the job of assisting in the repair of a large 500-volt three-phase 25-cycle induction motor, which was directly connected to a direct-current generator. It was a three-bearing equipment, the motor's rotor and generator's armatures being keyed on the same shaft. The middle-bearing housing was mounted on the motor and was split horizontally as in Fig. 1. In taking the machine apart to get at the stator winding in the motor, the inner bearing was removed, the base bolts and dowels taken out and the stator pushed out so that the end of the rotor shaft was only one-quarter way in the outer bearing, then a jack was set under the shaft as close as possible to the rotor and the weight of the latter taken on it, a wooden block being placed between the jack and the shaft to prevent injury to the latter. Then an extension to the bedplate was built with timbers, and after this the outer bearing was removed and the stator pushed out on the beams so that the winding could be repaired.

The bottom coils had become soaked with oil, rotting the insulation, and no doubt the vibration of the coils

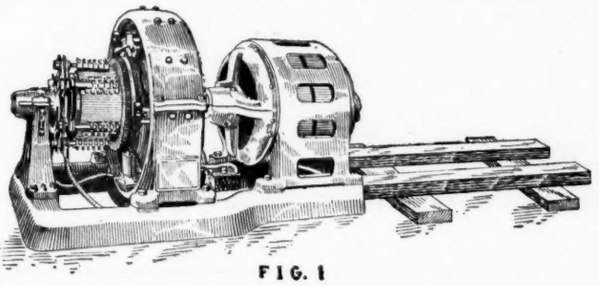


FIG. 1

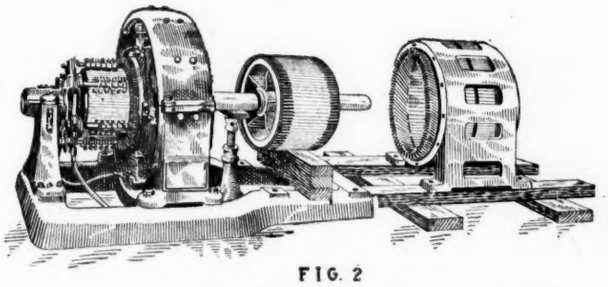


FIG. 2

FIGS. 1 AND 2. MOTOR ASSEMBLED AND STATOR REMOVED FROM BASE

themselves did the rest. The little old juice jumped to ground and put some twenty coils on the casualty list. As luck would have it we had sufficient spare coils in stock to do the job. With two men working, one on each end of the winding, the damaged coils were quickly removed with pinch bars and coil lifters. The tools used to lift the coils were like those shown in Fig. 3. No. 2 was used to raise the coils a little at one end, then No. 1; the wedge-shaped one was pushed under the coils in the slots and used to pry them up. No. 3 has projecting shoulders which rest on top of the slot and is used as

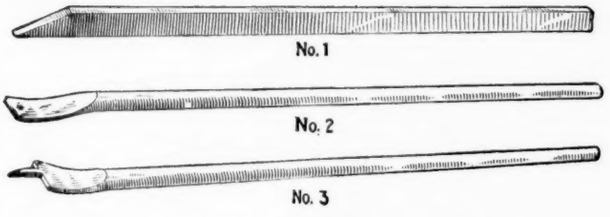
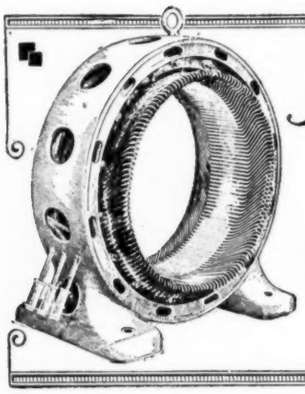


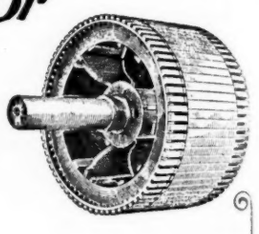
FIG. 3. TOOLS FOR REMOVING COILS

a powerful lever for lifting tight coils. They are all made of steel in sizes to suit small or large machines. The edges, of course, are nicely rounded in order to prevent damage to the coils. When the machine was again ready for service it was easily assembled by reversing the dismantling operations.

The development of the great waterfalls of Iguazu in the northern part of Argentina, will be undertaken by the Argentine government, which has the matter of turning the energy of the falls to commercial use under consideration. These falls, located in an almost inaccessible district, are visited only by tourists, many of whom claim that they are larger than Niagara.



How an Induction Motor Operates as an Induction Generator



By F. A. Annett

Describes how the current is set up in the rotor bars of an induction motor, and how this current acts upon the stator flux to produce rotation. Also shows how an induction motor can be made to operate as a generator.

IN THE article, "The Revolving Magnetic Field of Alternating-Current Motors," in *Power*, Sept. 2, it was shown how a revolving magnetic field could be produced by an arrangement of windings like that in Fig. 1, connected to a two-phase circuit. In the discussion in that article the magnetic field was made to revolve in a clockwise direction. Starting with this assumption in this article, consider the action of the field on the rotor, to produce rotation. Assume the rotor to be at standstill, as at the instant of starting, and with the magnetic field revolving in a clockwise direction. The lines of force will be cut in a counterclockwise direction. This condition is the same as though the magnetic field was stationary and the rotor was revolved in a counterclockwise direction. This will be made clear by referring to Figs. 2 and 3. In Fig. 2 assume conductor *A* to be stationary and the magnetic field moved horizontally in a right-hand direction, as indicated by arrow *B*. Then the magnetic field would be cut by *A* from right to left. This would be the same as if the magnetic field were held stationary and the conductor moved horizontally to the left, as shown by arrow *B*, Fig. 3. When the conductors are cutting the lines of force in a counterclockwise direction, Fig. 1, those under the N poles will have a voltage induced in them that will cause a current to flow toward the reader, as indicated by the dots on the end of the conductor. The conductors under the S poles will have voltage generated in them that will cause current to flow down through the plane of the paper, as indicated by the crosses on the end of the conductors. Considering the action of the current in the rotor conductors on the magnetic field from the polepieces will show that it produces a turning effort in a clockwise direction; in other words the rotor in an induction motor turns in the same direction as the magnetic field revolves.

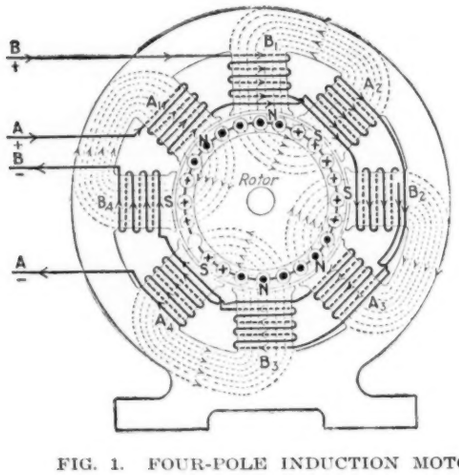


FIG. 1. FOUR-POLE INDUCTION MOTOR

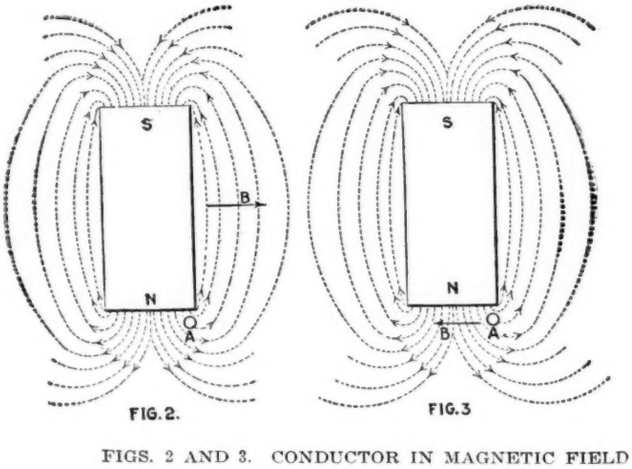


FIG. 2. FIG. 3

FIGS. 2 AND 3. CONDUCTOR IN MAGNETIC FIELD

At the instant of starting the rotor is at a standstill and the magnetic field is revolving by the rotor conductor at a speed, as was shown in the previous article, which equals 120 times the frequency divided by the number of poles, or, for a four-pole machine on a 60-cycle circuit, equals $120 \times 60 \div 4 = 1800$ revolutions per minute. This gives the maximum rate of cutting the lines of force, and consequently generates a maximum voltage in the rotor conductors of a frequency equal to the voltage applied to the stator.

Why the frequency of the rotor current will be the same as that of the stator current will be understood when it is remembered that in the previous discussion the polarity of the field coils changed with each alternation; therefore if the polarity of the field coils

changed with each alternation, the voltage generated in the conductors under the polepieces will change with each alternation.

Assume that the magnetic field is rotating at 1800 r.p.m. and that power is applied to the rotor and caused to also run at 1800 r.p.m. in the same direction as the magnetic field. Under such a condition the motor conductors and the magnetic field would be running at the same speed, therefore the former would not be cutting any of the lines of force, consequently the voltage in the conductors would be zero and no current would flow in them. From the foregoing it is evident that when the rotor of an induction motor is at a standstill the voltage and frequency are at a maximum, but that as the rotor comes up to speed, the voltage and frequency of the rotor current decrease until when the rotor is running at the same speed as the magnetic field, the voltage and frequency become zero. Since no current flows in the rotor conductors when they are moving at the same speed as the magnetic field of the stator, no torque, turning effort will be produced. In the foregoing is found the explanation why the rotor of an induction motor must run slower than the stator's magnetic field. The rotor runs just enough slower than the field to set up sufficient current in the rotor bar to develop the torque necessary to drive the load. If there is no load on the motor, then the rotor runs at practically the same speed as the magnetic field, but as the load is increased the speed decreases until at full load the difference in speed will amount to from about 3 per cent. for large, efficient machines to about 10 per cent. for small machines. The difference between the speed of the magnetic field and the rotor is called the slip and is usually expressed as a percentage of the speed of the magnetic field, which is the synchronous, or theoretical, speed. Where S_m represents the speed of the stator's magnetic field and S the speed of the rotor,

$$\text{per cent. slip} = \frac{S_m - S}{S_m} \times 100.$$

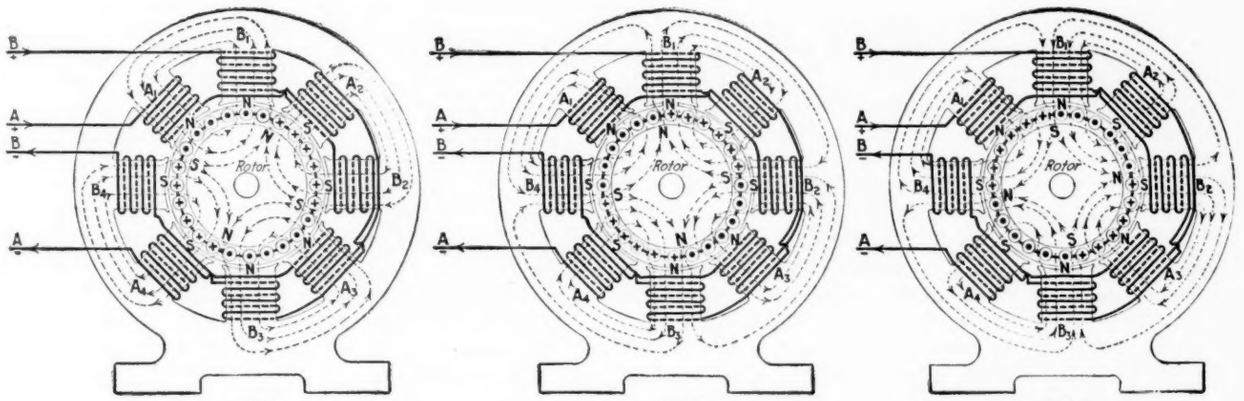
Assume that a four-pole 60-cycle induction motor runs 1675 r.p.m. at full load, find the per cent. of slip? In the foregoing it was found that the theoretical speed of a four-pole 60-cycle motor is 1800 r.p.m., then the

$$\text{per cent. slip} = \frac{1800 - 1675}{1800} \times 100 = 7;$$

that is, the rotor is running about 7 per cent. slower than the magnetic field of the motor. The speed marked on the nameplate on induction motors is usually the full-load speed, consequently somewhat less than the theoretical speed figured from the number of poles and the frequency.

The current taken from the line by the stator of an induction motor is not only limited by the ohmic resistance of the stator winding, which is always comparatively small, but also by the counter-voltage generated in the winding, the latter being almost equal to the applied volts, there being only sufficient difference to allow the current to flow necessary to carry the load on the motor. The counter-voltage induced in the stator winding is similar to the counter-electromotive force generated in the armature of a direct-current motor. In the latter case this back pressure is produced by the armature conductors cutting the lines of force from the polepieces, where in the former it is induced in the stator winding while the alternating magnetic field changes in value about the conductors. At no load the current taken from the line is that necessary to magnetize the stator and rotor core and supply the losses in the motor.

If we consider the action of the current in the rotor bars alone, as in Fig. 4, it will be found to produce a magnetic field as shown. This is the resultant field from the clockwise field set up about the conductors carrying current away from the reader and the counter-clockwise field set up about the conductors carrying current toward the reader. By comparing Figs. 1 and 4 it is seen that the center of the magnetic field of the rotor is located between the poles of the stator. This is the condition to be desired, since the rotor poles exert a minimum demagnetizing effect on the stator poles, and also all the rotor conductors under each pole are carrying current in the same direction, consequently producing a given torque with a minimum current. However, owing to the effect of inductance in the rotor the current lags behind the voltage generated in the rotor conductors, and instead of the current being distributed as indicated in Fig. 4, the actual conditions approach those of Fig. 5. Here it is seen that, owing to the rotor current lagging behind the voltage, the rotor's N and S poles come considerably back under the stator's N and S poles respectively. Consequently, the rotor poles have a demagnetizing effect on the stator poles. In fact the rotor current of an induction motor has the same effect



FIGS. 4 TO 6. SCHEMATIC DIAGRAMS SHOWING MAGNETIC FIELD DUE TO ROTOR CURRENT IN AN INDUCTION MOTOR

upon the stator as the secondary winding of a transformer has on the primary.

Assume that power is applied to the rotor, Fig. 1, and it is caused to run faster than the magnetic field. Under such conditions the rotor conductors will be cutting the stator field in an opposite direction to that shown in Fig. 1, consequently the voltage and current set up in the rotor conductors will be opposite to that in Figs. 1, 4 and 5. The conditions with the rotor running faster than the magnetic field are shown in Fig. 6. Now if the current set up in the rotor when it is running slower than the magnetic field is a demagnetizing current, the current set up in the rotor when the motor is caused to run faster than the magnetic field is a magnetizing current. This is at once evident from Fig. 6. Here we find that the north poles of the rotor are under the S poles of the stator and the S poles of the rotor under the N poles of the stator. This brings about a condition where the rotor current can supply the necessary magnetic field to generate the counter-voltage in the stator windings. However, when the rotor has increased in speed a small percentage above that of the magnetic field the counter-voltage of the stator will have increased above the applied voltage and the motor will become a generator. Then, instead of the machine taking power from the line to drive it, as a motor, it will require mechanical power applied to the rotor to drive the latter faster than the magnetic field, and the machine becomes what is known as an induction generator.

From the foregoing it is seen that an induction generator is nothing more nor less than an induction motor with some source of motive power applied to its rotor to drive it faster than the stator's magnetic field. An inductor motor used to drive an elevator acts as an induction generator when the car is traveling in the down motion under heavy load; the motor becomes a generator and pumps current back into the system, which causes it to act to prevent the car from racing.

Induction generators have been used to some extent, driven by low-pressure turbines in parallel with reciprocating-engine-driven alternators, the steam turbine being run without a governor and the speed being taken care of by the steam-engine governor. Probably the most notable installation of this kind is that in the Interborough Rapid Transit Company's 59th Street plant in New York City, made a number of years ago. In this plant there are five of these machines, each of 7500-kw. capacity, driven by low-pressure steam turbines operating in parallel with the 7500-kw. steam-engine-driven units. Other cases where induction generators are used are in small water-power plants tied in on a large system. The waterwheels are run without a governor, consequently the machine operates up to its full capacity continuously. Such plants are generally operated without an attendant, except probably an inspection once per day.

The chief advantages of such machines is their sturdy construction and the fact that they require no source of direct-current excitation. On the other hand, the machines are not capable of exciting their own field, consequently must operate in parallel with standard-type alternators. If it were possible to maintain a leading power factor on the system, an induction generator could be operated alone after it had been brought up to speed and connected in on the line. However, this has not been found feasible in general practice.

Relation Between Carbon Dioxide and Rated Capacity

By B. J. Lewis

We are told that the presence of 15 per cent. of carbon dioxide in the flue gases is indicative of complete combustion. In general this is accepted as the amount one should obtain. This will result at times in an increase in the cost of steam generation instead of a saving, owing to the fact that no attention has been paid as to the quantity of steam generated.

The benefits derived from the flue-gas analysis cannot be overestimated when they are conducted properly, and we agree that high CO_2 is indicative of high furnace efficiency when properly applied, but we must also agree that it is not always indicative of high boiler efficiency. There are, of course, exceptions to all rules. In this case it would apply to a boiler and furnace where capacity is sought without regard to efficiency, but where the relation can be worked out I believe it is the proper policy to follow. At the same time the flue-gas analysis is taken, it is not a bad idea to have a record of the escaping gas temperatures, as with this sort of a record it is possible to determine the amount of heat being absorbed by the boiler.

I do not say that high boiler efficiency is impossible with a high percentage of CO_2, but I do say that a relation between the CO_2 percentage and the capacity developed should be determined for each unit or plant; such determinations are made by many well-known plants, and the results have proved satisfactory.

After the CO_2 instrument has been installed, you should not be satisfied when you have gained a high percentage of CO_2, but should learn your relation between the CO_2 percentage and the amount of steam generated, which in turn will give you information as to the proper amount of CO_2 that will deliver the highest boiler, furnace and grate efficiency.

When the differential draft gages are mounted at the furnace and damper and the CO_2 instrument is put into service, I have always found that the relation between CO_2 draft and fuel thickness gives helpful information.

Following is a method for conducting on a boiler a test by operating the boiler at different capacities until the exact relation between the percentage of CO_2 and the capacity is found. It is sometimes necessary to make certain changes in the furnace or method of damper regulation and we have made changes where we could maintain higher CO_2 and at the same time get better boiler efficiency. As fast as the determinations are made, each steam-flow indicator is marked at the horsepower that gives the highest over-all efficiency, and the firemen are instructed to keep it at that point.

We also use CO_2 recorders, steam-flow recorders, recording thermometer and recording draft gage, which puts us in a position to know just what efficiency we are getting.

That the airplane engine is not above ordinary humdrum work is shown by the fact that one has recently been installed in a London factory as a stand-by power unit. It burns gas and the cooling water is circulated through a common cast-iron radiator. It is an eight-cylinder engine and is rated for aërial work at 200 hp., but this rating has been reduced for its present work to 57 hp. The space occupied by the engine is only 8 x 5 ft., and 5 ft. high, and its weight about 800 pounds.

EDITORIALS

Use of Fuel Oil in New York City

IT IS probable that the laws and ordinances relating to the storage and use of fuel oil in New York City will soon be so modified that the steam plants of a number of office and commercial buildings may be equipped with oil storage and burning appliances in time for operation during the coming winter. In many of the large cities of the Western States fuel oil is extensively used for the generation of steam in commercial and manufacturing establishments, but in New York the restrictions of public ordinances and insurance regulations, with respect to storage and use of kerosene and more volatile liquid fuels, has heretofore been construed by the municipal authorities as applicable to all kinds of fuel oils, and the conditions imposed have made the use of liquid fuels in the congested sections of the city all but impossible.

Urged by the coal shortage and increased cost of labor for handling coal and ashes, the owners of many office buildings have insisted that if, in Chicago, San Francisco and other large Western cities, fuel oils can be stored and used with safety, and with fuel oils offered on favorable terms, it is high time that blind conservatism should no longer stand in the way of equal advantages for New York City.

When the safety with which fuel oil can be stored and used for heating and power purposes and the immunity from any special danger of fire or explosion that has been experienced in other cities were brought to the attention of the Board of Standards and Appeals, steps were taken to appropriately amend the existing regulations, and on September third the board held a public hearing on a tentative draft of amendments of rules governing the storage and use of fuel oils and the construction and installation of oil-burning equipment. The hearing developed the fact that while the proposed modifications of existing regulations respecting the storage and use of kerosene and more volatile liquid fuels for domestic and manufacturing purposes were wise and necessary for public safety, the same general restrictions applied to heavy fuel oil would make its use prohibitive, mainly from difficulties arising from requirements of storage tanks.

Guided by suggestions supplied by the American Society of Liquid Fuel Engineers and the representative of the National Board of Fire Underwriters, the Board of Standards and Appeals will revise their tentative draft of proposed rules and have held a number of public hearings on the subject.

In order that there may be as little obstruction as possible to delay installation and use of fuel-oil equipments, it is expected that the board will request the Board of Aldermen to pass an ordinance at an early date, permitting the use of fuel oil in heating and power plants provided the methods to be employed are in accordance with plans filed with and approved by the Board of Standards and Appeals.

The Synchronous Motor Coming Into Its Own

IN ITS general construction a synchronous motor is an alternating-current generator operated as a motor. However, to give the machine stability in operation and make it capable of developing considerable starting torque, it requires a squirrel-cage winding in the pole faces. As the machine was first constructed and operated, it was very unstable, having a marked tendency to hunt, and was affected by disturbance in the system. This hunting frequently became serious enough to cause the machine to fall out of synchronism and stop. On account of its low starting torque this machine also required an auxiliary source of power to bring it up to speed so that it could be synchronized as an alternator before connecting it to the line, after which the mechanical load was thrown on through a clutch and the source of auxiliary power cut out. If all these operations were properly made by an expert attendant, the motor was put on the system without any serious disturbance. When the complicated operation of this early-type synchronous motor, and in many cases its unsatisfactory performance, was compared with the squirrel-cage motor, which in small sizes could be started by throwing them directly across the line or in the larger sizes required only an auto-transformer connected to a double-throw switch for starting, it is obvious how the former type was soon practically disregarded as a medium of converting electrical energy into mechanical.

This bad name that the early synchronous motor developed for itself still remains with it in many cases. Users of power are not infrequently met who feel that the synchronous motor is the same trouble maker as its early-day predecessor. They still have in mind a motor with a poor starting torque, requiring an auxiliary starting equipment. To put clearly before its readers what a modern-type synchronous motor will do and will not do, *Power* is going to publish a number of articles treating different aspects of this subject. The first of these appeared in the issue of September second. In this way it is hoped to give the reader an opportunity to familiarize himself with the characteristics of this type of motor, which is coming into extensive use for certain types of drive and will no doubt be an important factor in the future application of alternating current.

The squirrel-cage type motor must always operate at a lagging power factor, being about eighty-five per cent. at full load of the motor and decreasing rapidly as the load decreases. Where a number of partly loaded induction motors constitute the load on the system, the power factor must be low. The power factor of the synchronous motor can be controlled by the field excitation. By increasing the field strength above that to give normal excitation of the motor, it can be made to compensate for the low power factor of the induction motors on the system. There is little doubt that the power-factor correcting characteristics of the synchronous motor will have a far-reaching influence in its wider adoption.

A number of the central stations have a power-factor clause in their contracts, penalizing for low power factor, which, in the light of modern electrical engineering, is justifiable. One of the reasons for not introducing this power-factor clause more generally is the lack of some standard definition of power factor and method of measuring it on unbalanced polyphase systems. However, a joint committee of the A. I. E. E. and the N. E. L. A. have the defining of the power factor on polyphase circuits, both balanced and unbalanced, and the recommending of some standard of measuring power factor under consideration. There is little doubt that this committee will report favorably on some standard definition for and method of measuring the power factor on polyphase systems, after which it is probable that the power companies will give greater consideration to what the power factor of their customers' loads are. Therefore it is of interest to those who may have power-factor correction problems to solve to give the subject serious consideration at this time.

Importance of Intelligently Blowing-Down Boilers

THE subject of blowing-down boilers is one which, in many cases if not in most, is treated far too lightly from a standpoint of boiler efficiency. In many plants throughout the country the question has been asked, "How much water do you blow out of your boilers daily?" Invariably, the answer has been, "I don't know, I've never measured it." Further questioning has disclosed the fact that the attendant usually blows down a gage or two every shift, but has no definite idea as to the amount or its effects, working mechanically, much the same as a man winding a clock. It is this lack of information on such a vital subject that results in a great deal of the trouble experienced by plant owners from what is generally called "priming."

Through the standardization of water columns and their fixtures, it has become a habit to call a gage of water a gage, and without further thought on the matter, if the plant to be operated has more than one type of boiler and the attendant is told to blow down two gages every twelve hours, he inadvertently discriminates against one or the other of the boilers. For example, the old-fashioned horizontal return-tubular has a much greater water-holding capacity in the shell situated in a horizontal plane opposite the water column than that furnished in a well-known type of vertical water-tube boiler, and the blowing down of a gage of water in the former would get rid of twice as much of the concentrated impurities as would be discharged from the latter.

A study of the matter will disclose the fact that, barring boilers of the same type and size, there are no two boilers designed with the same ratio of water-holding capacity represented by blowing down one gage to that of the water-holding capacity of the entire boiler, and as these ratios increase or decrease, so does the tendency of the boiler to prime in a given time follow suit.

With the foregoing condition facing the plant owner, he should have a chemical analysis of the raw and also one of the concentrated water made to arrive at the limit of impurities his particular case will stand and then figure just how many pounds of makeup water he will have to replace through blowing down each shift to dilute the remaining mass of water to a point where it will not prime. This information can be readily reduced to a certain number of gages to be blown down so many times a shift.

In this way and only this can the owner rest assured that he is getting the best results from all standpoints.

Will improving low power factor pay a dividend to the power user? is a question that is of serious concern to many power consumers at the present time. In our report on the twelfth annual convention of the Pennsylvania Electric Association, published elsewhere in this issue, are given the results of an investigation into a one thousand kilovolt-ampere load having a power factor of sixty per cent. Installing a static condenser on this system to raise the power factor to ninety per cent. would result in a saving that would pay for the installation in two and one-half years. These figures indicate that in many alternating-current industrial plants the wide-awake engineer may find that it is possible to effect considerable saving in the cost of power by improving the power factor of the load.

In testifying before the Senate committee which is investigating the coal situation, Francis S. Peabody contended that the coal operators are doing their best to hold down coal prices, that in certain sections they could easily get a dollar more per ton, but that they are afraid further advances might lead to nationalization of the coal mines. A frank statement, upon which the consumer will offer thanks for the beneficence of the operator, but at the same time rejoice that there yet remains one force that the latter fears.

How many engineers ever gave real serious thought to the value of a draft gage in the boiler room? How many have found them worth while, and why? How does an engineer know by the reading of such an instrument how and whether the proper amount of air is going into the furnace? How many have noted a saving after installing a draft gage, and how much was it? These are questions worth looking into, and if no attention has been paid to the value of draft gages, it is time it was done.

Smoke prevention received a serious setback during the past two years on account of coal conditions and the necessity of devoting all attention to forced production while the war lasted. Now that normal conditions are returning, efforts may again profitably be directed to the smoke problem.

What does accounting do, that power stations may benefit by it? It is an analyzer of business, that shows where and how the plant is making or losing money. And the most important part of it is, that one can find out at the same time *why* one is losing money.

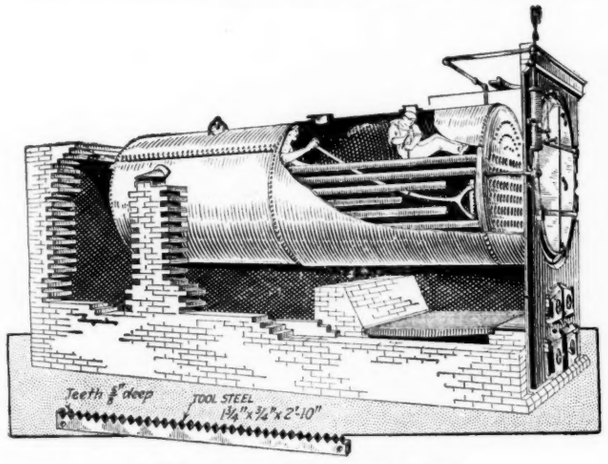
There are many ways of doing any given thing, but relatively few good ways and only one best way. Good methods suggest better methods, and the better methods lead to the best method, which is the goal—Success.

Ambition counts. A man neither rises above his highest thought nor falls below his lowest desire.

Correspondence

Tool for Removing Boiler Scale

Considerable trouble is experienced in boiler plants due to the accumulation of scale between the tubes and on the boiler head and it is usually a difficult task to remove this by mechanical means. A tool that I have designed and used for some time has proven its worth. I use it for removing the hard scale that accumulates between the tubes and on the head of return-tubular boilers and I have not had a leaky tube since I made and used the tool.



APPLICATION OF SCALING TOOL

The tubes on our five boilers are very close together and we found it was difficult to wash out or scrape out the scale between the tubes and around the heads. This tool certainly makes play out of the work now. The head is steel, 1¾ in. thick and 2 ft. long. On one side are teeth which are ⅝ in. deep. The head is set in a frame the handle of which is 5 ft. long and curved.

In operation, the tool (see illustration) is let down between the tubes by means of a chain and by adjusting its length, the toothed side of the tool is swung toward the head and a few hard blows with it causes the scale to loosen and fall to the bottom of the boiler.

Kaukauna, Wis. CHARLES O. KUDER.

Valve Disks from Carbon Brushes

The following hints are for making use of worn-out carbon or graphite motor brushes. I used to have to replace the long disks on the water column try-cocks about every two weeks. They were made of hard rubber and used to buckle from the heat.

The disks on the top try-cocks gave the most trouble. Knowing of the heat-resisting quality of carbon I made new disks out of the carbon brushes and solved my try-cock disk troubles.

On several occasions I made valve disks of worn-out brushes, also steam radiator air-valve disks, which gave good results. FRANK ZAVATSKY.

New York City.

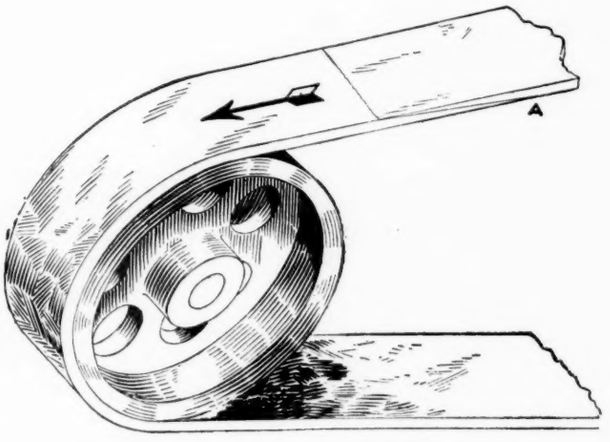
Why the Arrow on Belting?

Manufacturers of leather belting frequently stamp their belts with an arrow designating the direction in which they should be run. It is my understanding that, if the belt is run as indicated by the arrow, the thin edges of the splices next the pulleys, point *A*, will be the last point of the splice to reach the pulleys.

The usual reason given for running the belt in this direction, is that it prevents the possibility of the splice edge being pulled loose and curled up, due to the friction between the belt and pulleys.

It would seem at first glance that the running of the splices as shown in the illustration is correct. It would be if the pulleys were stationary and the belt sliding over them. However, if consideration is taken of the relative velocities of belt and pulleys, it appears to render the question of direction one to be solved for each individual drive.

Owing to the slipping of the belt, the driving pulley face runs faster than the belt and the belt faster than the driven pulley face, so that the action is as if the belt were slowly pulled backward over the driver pulley and forward over the driven pulley. The result



WHICH WAY SHOULD THE SPLICE RUN?

is, that no matter in which direction the splices are run, they will run onto the face of one of the wheels in the wrong direction.

If the foregoing analysis of the action is correct, it appears that before the application of a belt, the probable relative slipping of the two pulleys should be determined, taking into account arcs of contact, coefficients of friction and radii, and the splices run in favor of the pulley that is expected to slip the most. If the driver leads in the slipping, the points of the splices next to the pulleys should lead onto the pulleys; but, if the driven pulley is the greatest slipper, the points of the splices should follow onto the pulleys as shown. M. W. DAVIDSON.

Vermilion, S. Dak.

The Maximum Length of a Longitudinal Boiler Joint

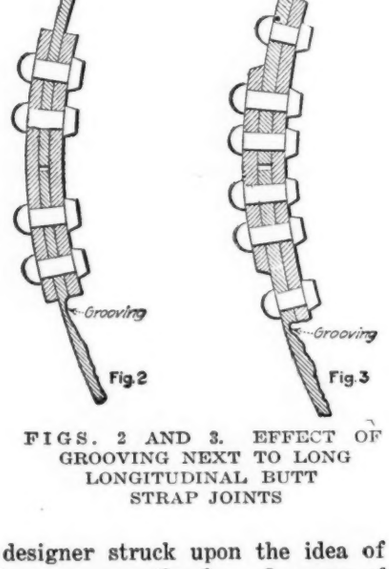
The question of a longitudinal joint asked in the July 1 number of *Power* is a good one and should set some boilermakers, engineers and inspectors to studying one of the principal features of boiler design.

In the early days when the rolling mills could not roll wide plates, it was necessary that steam boilers be made in short courses, resulting in numerous girth seams. The girth seams that were over the fire, especially those near the bridge-wall, usually developed fire cracks which in time would cause leakage and necessitate frequent patching.

The placing of a patch frequently resulted in having two joints exposed to the fire instead of one, and the judicious use of the drift pin in the early days consisted of "A two hundred pound boilermaker swinging a 16-lb. sledge at the pin," and was the cause of fire cracks galore.

The numerous girth seams gave considerable trouble, so when the mills were capable of turning out wider

FIG. 1. CORROSION OF PLATE ON EDGE OF LAP-SEAM JOINT



FIGS. 2 AND 3. EFFECT OF GROOVING NEXT TO LONG LONGITUDINAL BUTT STRAP JOINTS

plates, some boiler designer struck upon the idea of eliminating the girth seams over the fire. In some of the older engineering books this type of boiler was described as "seamless over the fire," and was considered a good design; and, with reference to the elimination of the fire cracks it was. Boilers were built having one top and one bottom sheet, two top and one bottom, and three top and one bottom sheet.

Some of the leading insurance and inspection companies did not approve the above designs, claiming that boilers should have some girth joints, as each girth joint served as a band or hoop and added strength to the boiler; and the test of time has proven this to be true. There are on record a number of disastrous boiler explosions of this single-sheet bottom type of boiler.

An article was published in *Power* May 19, 1908, which should be read by those in favor of long longitudinal seams, or the elimination of girth joints. This article shows the results of tests made on a boiler which was built especially for a test of the relative merits of the different types of joints and illustrates very nicely the strengthening effect of the girth seams which act very much the same as the hoops on a barrel. The changes of temperature and pressure that steam boilers are subjected to cause expansion and contraction of the material, or what is termed the breathing action of the boiler.

Where corrosive feed water is used in boilers having long longitudinal seams, these boilers are very susceptible to grooving. Grooving is a combined chemical and mechanical action. The mechanical action is the breathing of the boiler, and causes minute cracks to develop in the shell plate close to the edge of the inner lap of the longitudinal seam. The acids in the feed water enter the cracks and attack the material, the flexing or bending of the plate continues to take place with the changes of temperature, and the corrosion continues and keeps advancing into the material, until the result may be as shown in Fig. 1.

It is known to the sorrow of some engineers and others, that the long longitudinal lap seam has proven itself a first class helper in the development of longitudinal lap cracks in steam boilers.

Long longitudinal butt-strap joints should not be encouraged, for grooving can take place under this type of joint as well as along lap joints. Figs. 2 and 3 show where this type of joint may be affected.

I believe it fair and just to compare a steam boiler with a beam. An 18-ft. boiler having continuous longitudinal seams and no girth joints is a parallel to a beam 18 ft. long and supported at both ends. A boiler having one girth seam midway of its length would compare with a beam supported at both ends and also in the center. A three-course boiler having two girth seams would be as a beam supported at each end, and also having two additional supports equidistant under it. Give me the short course for strength and safety and courses of 8 ft. would be preferable to 12 ft. courses in horizontal return-tubular boilers of the larger diameters.

Let every member of the *Power* family, who knows boilers, enter into this discussion, as it is well worthy of all the attention that can be given it.

Mt. Oliver, Penn. N. DEVERING.

Regarding the subject of the maximum length of longitudinal joints, few if any mills are prepared to roll plates more than 12 ft. wide. Plates of this width or greater are not uniform in structure and are not so reliable as narrower plates. I believe that the width of reliable boiler plate is reached at less than 12 ft. and I should say that 8 ft. is the limit in width. This may be contradicted by some plate manufacturers. This limitation is one that is not likely to be overcome by improvement in machinery or process. This then leads to placing the sheet lengthwise of the shell or drum for seams longer than 12 ft.

The tensile strength of plate being less at right angle to the direction of rolling, or crosswise of the fiber, and its ability to stand bending both from rolling into shells and the breathing action in service, is even less. This accounts for the fact that a large number of the horizontal-tubular, two-sheet, full-length, longitudinal-seam boilers built about twenty to twenty-five years ago have exploded from lap cracks of the full-length longitudinal seams.

It is certainly impossible to make a long riveted joint as strong as a short one, on account of the strain set up by the riveting. Although the rivet holes are drilled

from the solid, there is a buckling strain developed as the rivets are driven, which is multiplied by an increasing length of seam. This is because the longer seam is more difficult to calk tight and the more likely to leak in service.

As to why the Massachusetts and A. S. M. E. rules differ in regard to longitudinal seams, it is difficult to say; it is certainly not to be accounted for in fact.

No doubt the portion of shell exposed to the fire is under greater strain than that portion not so exposed, and the shells of locomotive boilers are called on to share most of the strains carried by the engine frames, in addition to pressure and shock from service, with most of them working at a factor of three and four, as against five in stationary practice. It would certainly make for safety to limit all longitudinal boiler seams to 8 ft. regardless of type of seam or boiler.

Richard City, Tenn. T. J. BLOSS.

The limit of from 10 to 12 ft. as the maximum length of longitudinal joints in certain types of boilers was no doubt established as a result of the numerous explosions of boilers apparently due to the long joint, of the lap type.

The butt double-strapped joint, it would seem, has overcome the difficulty experienced with the lap joint, and if in spite of the tests required by the A. S. M. E. Code to be made on specimens cut from the sheet parallel with the circumferential seams, there is still any doubt as to the safety of a longitudinal joint longer than 12 ft., then the various bodies of interested engineers ought to get together and prescribe tests which, when made, will determine beyond any question of doubt the safe maximum length of joint.

W. C. HECKEROTH, Chief Engineer,
Erie, Penn. Erie City Iron Works.

Superheated Steam—Why Not?

In the issue of July 1, page 23, there appears an editorial entitled "Superheated Steam—Why Not?" This editorial is on a subject very close to my heart, as I have been associated with a company that has pioneered in the construction of superheaters in this country and I have had to do with this pioneering for over fifteen years. Certain statements in the editorial can be so easily misunderstood by one who has not had experience with superheated steam that I feel the editorial should be answered.

In the first part it is stated that the average engineer considers that the use of superheated steam is confined to the steam-turbine power plant, or one equipped with reciprocating engines of the poppet valve type and that it is assumed that perhaps only 30 per cent. of the total horsepower of engines and turbines in this country use superheated steam and of this most of the use is confined to steam-turbine plants.

This assumption, from my own knowledge of superheater installations throughout the country, is far from correct. There is at present a very large horsepower of Corliss and slide-valve engines operating on superheated steam. It is true that superheated steam is not used in many of the smaller plants, but it may be said that in the larger and more important installations, a very large proportion of these plants use moderately superheated steam for Corliss and slide-valve engines. Even among the smaller power plants very many of them use superheated steam.

Following this, the editorial brings up two arguments that are advanced against the use of superheated steam for reciprocating engines; namely, difficulty of lubrication and the use of metal in cylinders and valves not suited to high temperatures. It asks the question whether suitable oil is procurable for high-temperature steam; the answer to this question is decidedly "yes." It also asks the question whether it is not more a question of maintenance and operation of engines rather than poor metal that causes trouble with lubrication. The answer to this question is yes and no, and which answer is correct depends largely upon the amount of superheat used. There are certainly engine cylinders and valves that I would never recommend for the use of high superheated steam, although I would strongly advocate the use of moderately superheated steam. It is a case of killing the goose that lays the golden eggs to put too high a superheat upon an engine or pipe line not suited to such high-temperature conditions. There is such a splendid saving from the use of superheated steam in moderation that there is no need to go to dangerous temperatures in order to obtain certain desired results. Superheated steam should certainly be used for reciprocating engines of the Corliss and slide-valve type, as these types of engines will show a very large saving with 75 to 100 deg. superheat, but to go to temperatures of 200 to 250 deg. superheat, mentioned in the editorial, would result in all kinds of trouble.

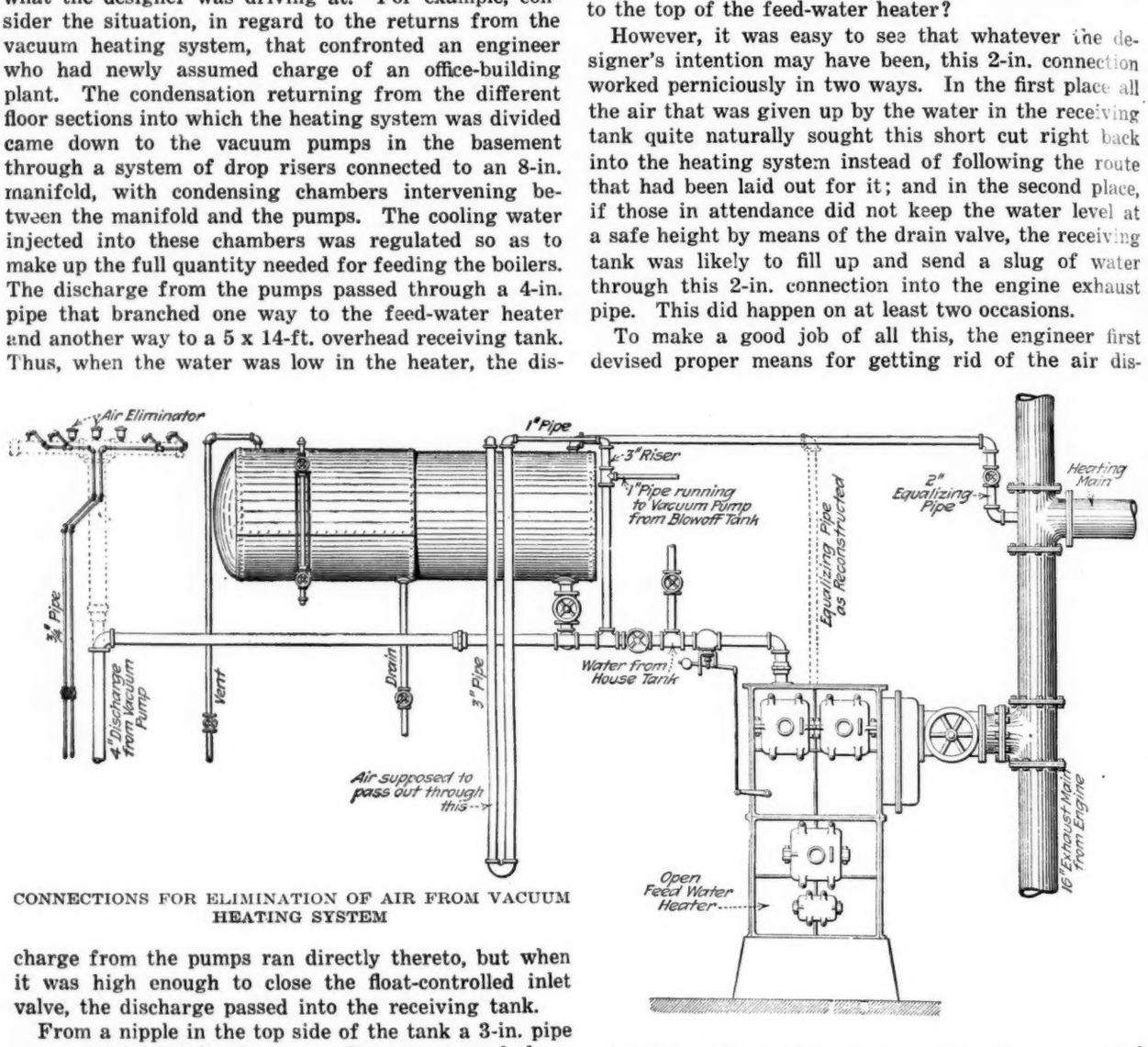
In connection with this statement as regards the use of 200 to 250 deg. of superheat a manufacturer of superheaters is quoted who claims the application of over 18,000,000 hp. in the stationary, marine and locomotive fields. There is only one manufacturer of superheaters outside of the one with which I am associated that could make a claim of this kind as to horsepower in the various fields mentioned, and this company's business has been practically entirely in the locomotive field where conditions are entirely different from those found in stationary practice. Two hundred to 250 deg. of superheat is commonly used in connection with locomotive superheaters. The locomotive has no piping system to maintain comparable with the piping system of the stationary power plant, neither have locomotives Corliss valves, and where they have slide valves these are changed to piston valves when superheaters are installed. The same company has installed superheaters in the marine field for highly superheated steam, but these engines also have no Corliss and slide valves on their high-pressure cylinders. When this manufacturer has had some experience in the stationary power-plant field, he will change his mind.

This answer to the editorial, coming from one who has made a study of superheated steam for a great many years and who is a strong advocate of the same, may, perhaps, seem strange, as the editorial undoubtedly intended to point out the advantages accruing from the use of superheated steam for reciprocating engines of the Corliss and slide-valve types. I feel, however, that many readers might be misled into considering high superheat for this type of engine and wish to do my part through publicity to correct any misapprehension that might be gained by reading the article, at the same time wishing to bring out as strongly as possible, the value of superheat in moderation, for such engines.

New York City. ROBERT H. WYLD.

Separating Air From Returns

Piping systems for various uses in a power plant are often designed in a way to baffle the understanding of an engineer who tries to figure out on his own account what the designer was driving at. For example, consider the situation, in regard to the returns from the vacuum heating system, that confronted an engineer who had newly assumed charge of an office-building plant. The condensation returning from the different floor sections into which the heating system was divided came down to the vacuum pumps in the basement through a system of drop risers connected to an 8-in. manifold, with condensing chambers intervening between the manifold and the pumps. The cooling water injected into these chambers was regulated so as to make up the full quantity needed for feeding the boilers. The discharge from the pumps passed through a 4-in. pipe that branched one way to the feed-water heater and another way to a 5 x 14-ft. overhead receiving tank. Thus, when the water was low in the heater, the discharge from the pumps ran directly thereto, but when it was high enough to close the float-controlled inlet valve, the discharge passed into the receiving tank.



CONNECTIONS FOR ELIMINATION OF AIR FROM VACUUM HEATING SYSTEM

From a nipple in the top side of the tank a 3-in. pipe ran out horizontally for some distance, turned down to the floor, and then looped up to the height of the ceiling, where it branched horizontally into a 1-in. pipe that connected to a 3-in. riser from the discharge branch running to the feed-water heater. From a tee near the upper end of this 3-in. riser a 1-in. pipe ran out and connected with the vapor pipe rising from the blowoff tank in the boiler room. These details are shown in the drawing. The engineer finally concluded that this bit of piping was something in the way of an air-expelling apparatus. The air that was pumped out of the heating system was supposed to separate from the water in the receiving tank and seek this route to the outer atmosphere.

From another nipple in the top of the receiving tank a 2-in. pipe ran across and connected to the main supply pipe of the heating system, exactly where the heating main branched out from the main exhaust pipe. What good purpose this pipe was intended to serve was a question that especially puzzled the engineer. Was it put there to transmit the initial pressure in the heating system to the overhead receiving tank and thus neutralize whatever retarding effect the pressure in the feed-water heater might have on the flow of water thereto? If so, why was the tank connection not made to the top of the feed-water heater?

However, it was easy to see that whatever the designer's intention may have been, this 2-in. connection worked perniciously in two ways. In the first place all the air that was given up by the water in the receiving tank quite naturally sought this short cut right back into the heating system instead of following the route that had been laid out for it; and in the second place, if those in attendance did not keep the water level at a safe height by means of the drain valve, the receiving tank was likely to fill up and send a slug of water through this 2-in. connection into the engine exhaust pipe. This did happen on at least two occasions.

To make a good job of all this, the engineer first devised proper means for getting rid of the air displaced by the vacuum pump. His device consisted mainly of a 6-in. riser from a tee at the point where the discharge pipe branched horizontally, the upper end of the riser connecting midway to a header pipe 5 ft. long and 4 in. in diameter. In the top side of the header were inserted three 1-in. nipples, to each of which was attached a patented air eliminator; also, two ¾-in. bleeder pipes, with four connections to the header, were run down to within a few inches of the floor. These were for convenience in relieving the system of unusual quantities of air, as when putting it in service after an overnight shutdown. The next improvement was to disconnect the equalizing pipe from the heating main and bring it down to the feed-water heater. These details are shown by the dotted lines.

After remodeling other features of the piping installation to his own satisfaction, the engineer found that he had a good many feet of fairly good second-hand pipe available for various uses.

A. J. DIXON.

St. Louis, Mo.

Engine Crosshead Pounds

In regard to the trouble experienced by Mr. Hollis with his engine, perhaps my experience may be of some help. The two accompanying diagrams were taken during my "doctoring" process, which will bear me out in my contentions and which also coincide with the editor's opinion as per his footnote regarding the compression on Mr. Hollis' engine.

Upon assuming charge of this particular engine, a 26 x 48-in. Corliss running over at 85 r.p.m., I found it running badly, and my predecessor told me that the bearings had to be adjusted very closely, especially the wristpin brasses, which, he said, needed taking up every day. He had no indicator, but I induced the company to furnish one and upon indicating found that the valves were in poor adjustment. I therefore set them as conditions seemed to warrant, and a smooth-running engine was the result.

When I showed the diagrams to the chief engineer of the company, he tried to persuade me that I was running too much compression, which is theoretically correct, but to prove that I was right in making an exception with that particular engine, I moved the exhaust eccentric back to where it was in the first place and no triphammer could make a worse noise than did that engine. The noise was all on the head end, as in Mr. Hollis' case, and a diagram showed an even setting, but with very little compression. When I lengthened the exhaust rod to a position that gave the diagram shown in Fig. 1, the engine ran noiselessly, which shows that no compression was required on the crank-end to prevent the pound, but with such unequal compression the engine did not run steadily, so I went back to my former setting, which produces the diagram shown in Fig. 2, and I have as well-behaved an engine as ever ran. The real trouble is caused by a mechanical imperfection in the engine which cannot be located without stripping and doing a careful job of lining up.

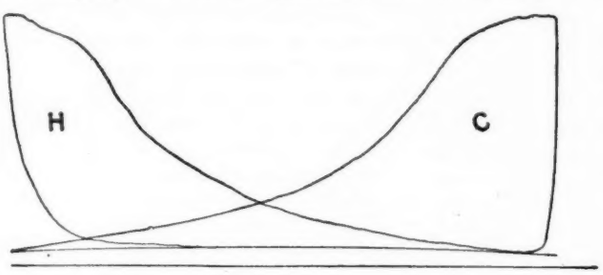


Fig. 1

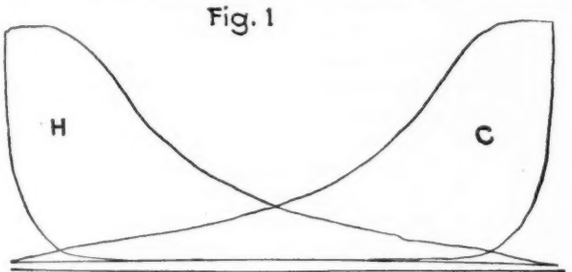


Fig. 2

FIG. 1. NO COMPRESSION ON CRANK END. FIG. 2. COMPRESSION ON BOTH ENDS

My opinion is that the theoretical dead centers are not the actual ones on this engine, which is proved by the fact that the engine requires no compression on the crank end but considerable on the head end.

I believe that the trouble with Mr. Hollis' engine is much the same as was mine, and of course, as his engine runs under, the crosshead could help out on the chorus by slamming down on the lower guide if there is any play.

If any engineer takes exceptions to my views as set forth, I extend to him a friendly challenge to visit my plant and determine whether I am right, and if he wins I will have learned something and will pay his expenses, otherwise he bears his own. L. M. REED.

Webster, Mass.

Scale Formed in Safety Valve

It used to be general practice in power plants to let the steam from the safety valve on the boilers discharge into the top of the boiler room. To overcome the disagreeable condition thus caused a pipe was extended from the safety valve until it projected through the roof of the boiler room.

With a long pipe going up through the boiler-house roof there is bound to be some condensation of the steam when the safety valve blows off. This condensation is supposed to flow out through a small hole drilled by the manufacturers in the valve body. For a while this hole performs its function, but in time becomes plugged up with scale. Then the condensate has no chance to escape from the valve and it forms into scale. This attacks the valve parts and the spring becomes corroded, and I have had to spend much time with a hammer and chisel cleaning the scale from the springs. The valve stem also becomes corroded in the dashpot, which is not a desirable condition, since the valve stem should work freely. The lower part of the valve stem is also attacked by the corrosive action, right under the spring, and I have taken out stems that were corroded halfway through. Have any *Power* readers had any such experiences as related, and what have they done to remedy them? THOMAS M. GRAY.

Bayonne, N. J.

Boiler-Tube Failures

There are some good practical points in Mr. Weaver's article on "Boiler-Tube Failures," in *Power* of June 10. Every reasonable man will agree with his conclusion that "nothing can be gained by snap judgment; it is a matter of careful analysis and good judgment to prevent the loss of tubes in water-tube boilers." Mr. Weaver's points on the importance of looking for oil in condensate and on the proper construction of furnace and baffles to prevent a blowpipe flame action are well made.

There is no doubt also that the majority of tube failures are caused by the accumulation of sludge or scale in the tubes. But it is where Mr. Weaver tries to explain how such scale and sludge can be prevented that it is hard to follow him. He is clear and correct when he argues against loosening up old scale by adding compounds that cause the broken old scale to drop down and bake together again on the lower tubes. But after condemning all such compounds, he finds the cure in a so-called "treatment" which he purchases and has a "caustic base." By changing from the common name of "boiler compound" to the more fancy term "treatment" and using the vague description "having a caustic base" Mr. Weaver feels reassured. What does this "having a caustic base" mean? If he

means containing caustic soda, why does he later condemn the excess of soda ash left in water softened by the lime-soda process? Soda ash and caustic soda look very much alike after a while under high temperature on the inside of a boiler.

The best that can be expected of a caustic compound at all is that it forms sludge instead of scale. But according to Mr. Weaver's own statements sludge is also harmful. It is the nature of all caustic compounds to cause this; it cannot be prevented by selecting the compound, but rather, it is the treatment with compounds altogether that is at fault. The trouble is that when any caustic compound is added, the tubes and belly of the boilers are used for the reactions that should take place outside of the boiler.

Since all hard water causes sludge or scale, and admitting that boiler-tube failures are caused in most cases by this sludge or scale, as Mr. Weaver stated, then the only real cure is to soften the feed water; that is, to remove the constituents in the water which cause the sludge or scale before the feed water reaches the boiler.

Users of compounds often excuse themselves by stating that lime-soda water softeners were so difficult to operate when it is so easy to put compound in a boiler. Mr. Weaver added another argument against softening plants, "the excess of soda ash" when stating the following: "My theory is that such an excess causes the water to foam," etc. He does not mention what he considers under "such an excess." The fact is, a softening plant can be so operated that there is no greater excess of "caustic bases" left in the water than the amount put into the boiler as compound. The correct application of the "safety first" measure requires an attendant who can properly operate the plant and its auxiliaries. However, a modern system of water softening is available and is simpler even than using compounds. When this zeolite softener is used, the water just flows through a closed or open shell containing the zeolite and the scale-forming salts in the water are automatically exchanged for soluble sodium from the zeolite. No scale or sludge is formed, and no excess of reagents can be introduced into the boilers.

S. B. APPLEBAUM,

New York City.

The article on "Boiler Tube Failures," by Waldo Weaver, page 88 of the June 10 issue of *Power*, applies more to other parts of the country than it does to New York City. We have been extremely fortunate in being supplied with water which, for boiler purposes, could hardly be excelled.

However, I think Mr. Weaver is somewhat pessimistic regarding tube failures, especially from what is called "floating scale." Several years ago I had a similar experience with loose scale, and it was mainly due to the refusal of the chief engineer to allow the boilers to be turbined because of a shortage of boiler capacity. Finally, a broken condenser tube filled the boilers with salt water, and before we knew it the lower row of tubes in four boilers—84 tubes in all—were bagged and leaking. Each tube showed the same cause, a pile of floating scale over the failure. After the boilers were properly cleaned, no further trouble was encountered, although they were forced above rating.

I agree with the theory that tubes burn out owing to the formation of a steam pocket, but I have always found a coating of scale in the defective tube afterward. One of the largest plants in New York City operates its boilers normally at 200 to 300 per cent. rating, but leaves a boiler in service only about two weeks and keeps the lower rows of tubes clean. I believe the late H. G. Stott, superintendent of power of the Interborough Rapid Transit Co., was a firm believer in keeping boilers clean and free from scale and driving them the limit, which, with a forced-draft underfeed stoker, is pretty high.

Graphite will certainly loosen the scale but I do not think it is detrimental to boiler tubes if handled properly and carefully. The doses to feed boilers advocated by the manufacturers of this product are intended to get the scale out of a boiler in "jig" time, and they usually do. A badly scaled boiler is no place for graphite or any other mechanically acting boiler compound, unless the boiler is driven extremely easy and inspected often.

The subject of boiler-water treatment both inside the boiler and out has been ably treated in various publications. The basis of most feed-water treatments is soda ash or a combination of soda ash and lime. Incidentally, there is enough chemistry on the subject in these papers so that an engineer can learn how to test water for these treatments, and then use this as a starter in solving his own troubles.

I have found a combination of soda and graphite best for my own plant and advocate something like this: First, thoroughly clean the boilers, then feed soda ash daily or often enough to keep the alkalinity about the same. Feed a small amount of graphite at regular intervals and blow down the boilers regularly, also, look out for loose scale by frequent inspections. I admit that the foregoing may sound rather vague, but each plant is different and in practice it will work out satisfactorily. The soda will help the graphite to loosen the scale, and if this treatment is followed good results should be obtained. I do not, however, advocate this as a cure all, but with average conditions it will work well.

Graphite has been condemned. In fact, in my own plant the boilers, I was told, were in terrible condition due to its use. This, as I found out afterward, was due to cylinder oil that entered the boilers from a defective feed-water heater. The graphite mixed with this and formed a plastic substance, which was dangerous, as it adhered to the tubes. Repairing the heater and adding soda-ash treatment to the graphite corrected the trouble. Any plant engineer who has and uses oily returns, etc., in his boilers must be extremely careful in using graphite. However, if soda is used judiciously to kill the oil, graphite may be used with beneficial results.

The whole subject may be briefly summed up in one statement, that, barring corrosion, and other conditions being equal, the number of tube failures will be directly proportional to the rate at which boilers are operated. While this is true, however, conditions as a rule vary so much that each case has to be considered on its own merits.

WARREN D. LEWIS.

New York City.

The light output of Mazda lamps decreases slowly with age, but the average output through the life of the filament is a higher percentage of the initial value than that which is obtained by any other illuminant.

Inquiries of General Interest

Relative Capacities of Rubber and Leather Belting—What is the relative transmissive capacity of rubber and leather belting? C. W. C.

When a proper weight of duck is used in rubber belting, four-ply rubber belting is taken to have the same transmissive capacity as good quality, single, thick leather belting of the same width; six-ply rubber the same capacity as double thick leather belting and eight-ply rubber the same capacity as triple thick leather belting.

Testing Surface Condenser for Leakage—How may a surface condenser be tested for leakage? W. B. R.

Probably the best method to determine the amount of condenser leakage is to pass cooling water through the tubes at the normal rate of flow, at the same time maintaining the required vacuum with the air pump. The amount of water removed by the air pump is the leakage of circulating water into the steam space of the condenser. The most general test for determining whether or not there is any leakage is to close all connections and observe whether a vacuum once established can be maintained a reasonably long time. Where salt water is used for cooling, it can be determined while running whether there is any leakage, by adding a little silver nitrate to a small amount of the condensed steam; if there is no appreciable precipitate of white silver chloride, it may be assumed that the condenser does not leak.

Saving from Higher Temperature of Feed Water—Where the boiler pressure is 120 lb. gage, what is the percentage of saving from returning the condensation from heating coils to the boiler at 240 deg. by traps in place of returning the water to a tank and feeding the water at 180 deg. F? P. E. M.

In either case each pound of feed water, when converted to steam at 120 lb. gage, or 135 lb. per sq.in. absolute, would contain 1191.6 B.t.u. above 32 deg. F. When the feed temperature is 180 deg. F., then each pound of feed water for conversion into steam would have to receive (1191.6 + 32) − 180 = 1043.6 B.t.u.; and when the feed temperature is 240 deg. F, each pound of the feed water would have to receive (1191.6 + 32) − 240 = 983.6 B.t.u., or (1043.6 − 983.6) × 100 ÷ 1043.6 = 5.75 per cent. more heat. Whether this represents the actual saving of coal from use of the traps, in place of a receiving tank and feed pump, depends on the relative steam economies of the trap or feed pump that may be employed.

General Dimensions of Overshot Waterwheel—What should be the diameter, general dimensions and speed of an overshot waterwheel with flat-sided buckets, to develop 5 brake horsepower with 3000 gallons of water per minute? R. D. M.

The weight of water supplied per minute would be 3000 × 8.33 = 24,990 lb. A well-designed wheel with flat-sided buckets would have an efficiency of about 50 per cent. For development of 5 b.hp. the energy of the water would need to be (5 × 33,000) ÷ 0.5 = 330,000 ft.-lb. per min., and the water would need to be supplied with a total head of not less than 330,000 ÷ 24,990 = 13.2 ft. The surface velocity of the wheel should be about 6 ft. per sec. and the velocity of water supplied on the wheel should be double that, or about 12 ft. per sec., which is due to a head of about 2 ft. 3 in. If the wheel is to receive the water exactly at the top, the summit of the buckets should not be more than 2 ft. 3 in. below the top water level in the penstock, and the wheel should not be less than 13.2 − 2.25 = 10.95, or about 11 ft. diameter at the periphery of the buckets. Allowing for operation with 3 in. lift of the spout gate and discharge upon the wheel of 3000 gal., or 3000 ÷ 7.48 = 401 cu.ft. of water per min., at a velocity of 12 ft. per sec., or 720 ft. per min., would require a gate and inside width of spout of 401 ÷ (720 × $\frac{3}{4}$) = 2.23 ft., or about 27 in., and about 34 in. length of the waterwheel buckets between the shrouds. For a surface velocity of the periphery of the buckets of 6 ft. per sec., or one-half of the spouted velocity of the water, an 11-ft. wheel should be geared for a speed of (6 × 60) ÷ (11 × 3.1416), or about 10½ revolutions per minute.

Running Clockwise and Counterclockwise—When is an engine said to be running "clockwise" or "counterclockwise"? R. E.

A horizontal engine is said to be "running over" when the crank rises at the beginning of the stroke that occurs while the piston is moving toward the crankshaft or when the top of the flywheel turns away from the cylinder, and the term "running under" is applied to rotation in the opposite direction. Stationary engines usually are designed to "run over," so the pressure between the crosshead and the crosshead guide, due to the angularity of the connecting-rod, comes on the lower side of the crosshead only, and also so the belt, which usually leads away from the engine, will have the driving pull on the lower side. Hence the direction for running over is sometimes referred to as "running forward." The term "running clockwise" usually is intended to mean "running over," or forward, and in the same direction as the hands of a clock to an observer viewing an engine with the shaft to his right hand and the cylinder to his left. The terms clockwise and counterclockwise applied to an engine are often confusing, as the direction will be clockwise to a person standing on one side and counterclockwise to one standing on the other side, and it is best to confine the designations of directions of rotation to the terms "running over" and "running under."

Heat Required for Generation of Wet Steam—What is the formula for determining how much heat is required for generation of a pound of steam at 150 lb. gage and quality 98 per cent. from feed water at the temperature of 120 deg. F.? M. D.

The number of B.t.u. contained per pound of the steam is given by the formula,

$$H_w = h + qL, \qquad (1)$$

in which

H_w = Number of B.t.u. above 32 deg. F. in a pound of the wet steam;

h = Heat of the liquid, or number of B.t.u. required to heat a pound of water from 32 deg. F. to the temperature of evaporation corresponding with the pressure;

L = Latent heat of evaporation, or number of B.t.u. contained by a pound of dry saturated steam at the stated pressure, in addition to h;

q = Quality or fraction of a whole pound of the steam that has received the latent heat of evaporation

If t = the temperature of the feed water, then $t - 32$ = the number of B.t.u. contained by the water above 32 deg. F. before any heat is added to it in the boiler; and if x is the quantity of heat required for generation of a pound of the steam, then

$$x = H_w - (t - 32) = H_w + 32 - t \qquad (2)$$

and by substituting the value of H_w in (1),

$$x = h + qL + 32 - t \qquad (3)$$

For steam at 150 lb. gage, or 165 lb. absolute, the tables of properties of dry saturated steam give $h = 338.2$ and $L = 856.8$. With $q = 98$ per cent. and $t = 120$, by substituting in (3) the heat required is found to be

$x = 338.2 + (0.98 \times 856.8) + 32 - 120 = 1089.8$ *B.t.u.*

Pennsylvania Electric Association Twelfth Annual Convention

THE TWELFTH annual convention of the Pennsylvania Electric Association was held at Bedford Springs, Penn., with the Bedford Spring Hotel as headquarters, on Sept. 3 to 6 inclusive. It proved to be one of the most successful conventions held by this association, with 388 members and guests registering. One of the interesting features was the exhibition of 24 electrical manufacturing companies' apparatus. This exhibition was held in a large tent erected near the hotel, and is probably the first time that an exhibition of this kind was held under canvas.

There were three technical sessions, at which nine papers were presented. The first technical session was called to order at 2:30 p.m. on Tuesday, by President Thomas Sproule, The first paper presented, "Increasing Capacities of Existing Lines and Cables," by E. C. Stone, deals particularly with three-phase circuits and discusses the economical possibilities of increasing 2300-volt line capacity by increasing the voltage. It is pointed out that in almost every power-distribution network, where an existing 2300-volt system is sufficiently loaded to require an increase in capacity, it will be found desirable and economical to increase the line voltage to 4000 volts. Ordinarily, the insulation of line and connected installations on a 2300-volt system is heavy enough to stand 4000 volts, so that the only change necessary is to reconnect transformers from delta-delta to star-delta. By changing the voltage of a distribution network from 2300 to 4000, an additional 73 per cent. capacity and a materially better regulation can be obtained at practically no additional cost.

Effect of War on Boiler-Room Practice

The second paper, "The Effect of the War on Boiler-Room Practice," by J. A. Barnard, presented at the Thursday afternoon session, discusses the effect of the war on the boiler-room practice of the Philadelphia Electric Co. It is shown by the curves that the average evaporation from and at 212 deg. was approximately 8.6 lb. of water for a period of four weeks during January and February, 1918, against about 9.9 lb. for the same period in 1919. The curves are shown with the desire to convey the result of two different labor conditions—in the first case, very bad; in the second, a marked improvement in two months after the armistice was signed. It must be remembered that in the early part of 1919 the boiler-room equipment had not yet recovered from the hard siege through which it had passed, and still more encouraging results are expected later. In the conclusion in this paper it is pointed out that "too much emphasis cannot be placed on the appearance of buildings and plants. The surroundings help make the men. At Schuylkill No. 2, and especially at the new Chester station, which was built during the war, the architect has combined the ornate with the economical and substantial qualifications of a modern central station. The casual visitor remarks 'why clothe the revolving generators and steam boilers with such elaborate surroundings'? The answer is given by the operating engineer and the station operating force. The former is proud that his profession is becoming more recognized, and the latter are men of such caliber as will produce better results with clean surroundings that inspire rather than those that depress. Clean, cool locker rooms, with shower baths and modern conveniences, send the retiring shift home comfortable and clean. A completely equipped restaurant provides good substantial food at any hour of the day or night to all employees at less than cost price. So let it be remembered that if you improve personnel and moral first, efficiency and economy will be the inevitable result."

In the discussion on this paper it was brought out that there is a new proposition in the field today in conjunction with an induced-draft fan, being an installation of an air washer on the discharge side of the boiler, to wash the gases, thus eliminating a good bit of cinder before it reaches the stack, and also cooling the gases to a great degree, so that necessity of a high stack is obviated.

As to fuel oil and its possibilities in power plants the opinion was expressed that it seems to be ideal under some conditions, also that fuel-oil burning equipment is much cheaper to install and much easier to maintain, has fewer parts to operate, requires a smaller boiler-room crew, and there are no ashes to handle. However, the one great drawback in oil burning is the existing low rate for coal. If there was any good guarantee that the price of oil would be maintained anywhere near the price of coal, the former would be the ideal fuel.

Pulverized Coal in Power Plants

In connection with pulverized coal it was pointed out that it has some of the advantages that oil has, such as doing away with the stoker and ash-handling equipment, although this is offset to some extent by the equipment for the pulverized-fuel installation. However, it apparently had a margin of desirability in the fuel-burning proposition. It was the opinion that the one drawback to burning anthracite culm by central stations is the necessity of having immense boiler settings to take care of the peak load, but in stations where the load is fairly constant at all times, pulverized coal would probably be very desirable.

"Method of Operating a Meter Department in Scattered Territory," by E. H. Tyson, presented at the Thursday afternoon session, gives a proposed method of operation of the meter department of a central-station company whose lines cover a large scattered territory to enable it to perform its duties under the new conditions in an efficient and economical manner. It is the author's opinion that by the method described it would be possible not only to standardize the organization and methods of the meter department, but also to lay out the work in each division and district in a manner best adapted to its own local conditions.

The report of the engineering committee was also presented at the Thursday afternoon session. This report gives tentative specifications covering the construction of jointly used pole lines carrying electric-supply circuits and signal circuits. The report was prepared by representatives of the engineering committee of the Pennsylvania Electric Association, and the American Telephone and Telegraph Co. This report is an extensive one and, as published, covers 43 pages.

Friday Morning Session

The technical session held on Friday morning was called to order by President Thomas Sproule at 10 a.m., after which four papers were presented. "Economical Boiler-Room Practice for Medium-Sized Plants," by H. D. Bryans, was read by the author. In this paper are described in a general way the equipment installed and methods pursued in the operation of the boiler plant of the Counties Gas and Electric Co., at Norristown, Penn. The author lays considerable stress on the intellectual caliber of the personnel in the boiler room, and in closing his paper says: "In fact, we feel that a first-class head boiler operator, or what might be called a boiler engineer, is of as much—yes, greater—value to the plant as is the shift engineer in the turbine room. It is a hard matter to break down prejudice and tradition, and we have found that the men are prone to look upon the turbine-room engineer's job as their real goal. It is time that the idea that the men in the boiler room are mere coal shovelers or coal burners should disappear. Times have changed in this matter, as in all others, and I believe the time is coming when the goal will be that of the boiler-room engineer and not turbine-room engineer. At Norristown we have never given out bonuses or anything other than straight wages. We believe that local conditions have a great bearing on the success of such plants, and we feel that sure and steady work is better if the proper type of men can be procured."

In the discussion it was brought out that in one boiler room containing eight boilers, 300 tubes had to be removed per year when the feed water was not treated, but the number was reduced to three tubes in one year by the proper treatment of the feed water. Mr. Bryans pointed out that in his plant, where from two to twelve boilers are in operation, by treating the feed water the tube renewals had been reduced to 13 or 14 in three or four years, where before they started to treat the feed water it was necessary to remove whole rows of tubes at a time.

Selecting Switchboard for Moderate-Sized Plant

"Selecting a Switchboard for a Plant of Moderate Size," by G. E. Wendle, was the second paper presented at the Friday morning session. The author describes the procedure by which the selection of a switchboard for a moderate-sized plant was made for the Lycoming Edison Co., Williamsport, Penn. In order to determine some standard basis for comparison of switchboard types, the following features were considered essential: (1) Reliability of continuity of service; (2) safety to employees and the public; (3) facility of installation; (4) facility of inspection and maintenance; (5) economy in operation; (6) localization and isolation of troubles and consequent damages; (7) time required for resumption of service after any interruption due to the switchboard; (8) first cost; (9) reserve equipment required; (10) provision for future growth. Each one of these features is discussed in the paper.

An extemporaneous talk by H. P. Weaver on "Management of Men" brought forth considerable discussion. From this discussion it was evident that the executives of the central-station industry are giving serious consideration to their employees' welfare and that a great deal of constructive work has already been done toward this end.

The Friday morning session was closed by the presentation of a paper, "The Story of the Insulations," by C. E. Skinner. After a general discussion of the development of insulations, the author divides the subjects into insulating varnishes, mica, transformer oil, molded insulation, glass and porcelain insulators, sheet insulation, the enemies of insulation, and insulations of the future, giving a brief story of each. An abstract of this paper will be published in a later issue of *Power*.

The Saturday Morning Session

President Thomas Sproule called the Saturday morning meeting to order and then called on J. W. Myers to present his paper on "The Isolated Plant Costs as Influenced by the War." This paper is based on the important points developed in the discussion, "The Effect of the War on Isolated Plant Cost," presented at the Atlantic City convention of the National Electric Light Association, held May 19 to 22, 1919. The subject is discussed chiefly from the standpoint of the purchasing power of a dollar. An abstract of this paper will be published in a later issue.

The second paper, "Power-Factor Correction by Means of Static Condensers," by O. C. Roff, was presented by the author. It gives a description of the construction and application of the static condenser for power-factor correction. The cause and the effect of low power factor are discussed, and comparisons are made between the synchronous and static condensers for power-factor correction. In the discussion it was pointed out that a low-power-factor load was a high-cost load and that a synchronous condenser on each motor would be an ideal condition. It was the opinion that both static and synchronous condensers have their own distinctive fields of application; the characteristic of the system determining the character of the power-factor correcting device. It was brought out that Terrill regulators have been used successfully for controlling the field current of synchronous motors when used for power-factor correction. A suggestion was made that a symposium on power factor and power-factor correction be prepared and presented before the Pennsylvania State branch of the National Electric Light Association, in the near future.

In the discussion on Mr. Roff's paper the results of an investigation of the power factor of the loads of a number of large power users were given. This investigation found power factors varying from 45 per cent. in silk mills to 85 per cent. in factories using group drive extensively. A group of large customers averaged 64 per cent., largely owing to individual motor drives on machines requiring very high starting torque. In another investigation of a connected load totaling 1100 hp. at 440 volts, having a maximum demand, on a 15-min. interval, of 612 kw. at 65 per cent. power factor, or approximately 1000 kv.-a., it was found that a static condenser of 540 kv.-a. capacity installed on the system to raise the power factor to 90 per cent. would result in a saving that would pay for the condenser equipment in 2.5 years, not considering the vast improvement in the service to the customer.

The following officers were elected for 1919-20: President, W. R. Kenney, Connellsville, Penn.; first vice president, Henry Harris, Pittsburgh, Penn.; second vice president, E. H. Davis, Williamsport, Penn.; treasurer, H. S. Cantlin, Allentown, Penn. Members of executive committee (two year term): W. E. Long, Philadelphia, Penn.; J. H. Shearer, Altoona, Penn.; G. M. Gadsby, Pittsburgh, Penn. Henry N. Muller was elected to fill out the unexpired term of Henry Harris, who was appointed first vice president.

Convention New York State Branch I. U. S. E.

The New York State branch of the International Union Steam and Operating Engineers held its second annual convention at Syracuse, N. Y., Aug. 24 to 25, 1919. Nearly every local union in the state was represented by one or more delegates.

The convention adopted a number of resolutions favoring legislation which, if enacted, will tend to improve the conditions of the engineers of the state. All resolutions dealing with legislation passed were later in the week introduced in the convention of the New York State Federation of Labor and received the indorsement of that body. Among the resolutions adopted was one to amend the "day of rest" law, making it broader in scope; three weeks' vacation for city and state employees at the prevailing rate of wages; to have all employees of schools of the state paid the prevailing rate.

Consideration was given to license laws, and a resolution was adopted on this subject which provides that amendments to the New York City law must have the approval of the local joint executive board of Greater New York before it can receive the support of the State Branch or the indorsement of organized labor. Recognizing the importance of having the support of the organized workers of New York State in matters of legislation, the State Branch, by unanimous vote, decided to affiliate with the New York State Federation of Labor.

The convention engaged in discussions of many subjects affecting the welfare of the engineers, but particularly the question of wages and hours. After delegates from all parts of the state had explained the dissatisfaction with the present conditions which exists in their several localities, it became the unanimous opinion of the convention that working agreements mutually entered into by the employers and the engineers are the true solution of all differences between them.

Matt Comerford, past general president of the International Union of Steam and Operating Engineers, represented *Power* at the convention, and addressed the delegates at one of their sessions. Local unions Nos. 11 and 545 jointly entertained the delegates and visitors with a degree of hospitality that made everyone feel at home in Syracuse.

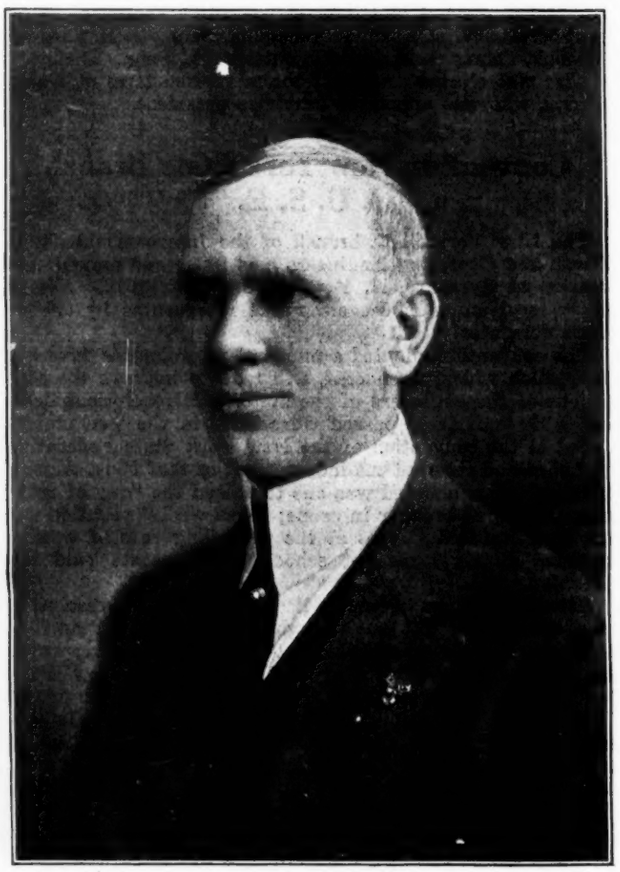
John P. Mallody, of Rochester, N. Y., received the unanimous vote of the convention for president of the State Branch, and Frank Lennon of the Bronx, N. Y., was elected State secretary and treasurer.

Suitable solders for aluminum are obtained by the use of tin and some zinc, or by both tin and aluminum within wide ranges of proportions. The solders should be applied without a flux and at high temperatures; the adhesion is said to improve with rising temperature of the tinning operation.—*The Engineer.*

John J. Calahan

John J. Calahan, newly elected president of the National Association of Stationary Engineers, has been prominent in engineering circles for many years.

Mr. Calahan first became identified with engineering in 1890 when he entered the employ of Miller & Bauer Co., machinists. Remaining with them until he finished his apprenticeship, he entered the mechanical department of the Standard Oil Co., later leaving to accept a position as engineer with the manufacturing company of Hanna & Hanna, subsequently rising to the position of superintendent. He remained with this firm until they retired from business. His next position was engineer for the Metropolitan Manufacturing Co., of New York. When the United States declared war with Spain, Mr. Calahan entered the



JOHN J. CALAHAN

service, being assigned to the auxiliary cruiser "City of Berlin." After returning to civilian life he accepted a position as engineer with the firm of Clarkson & Wainwright. In 1901 he was appointed by the Board of Education engineer in one of the large public schools of Jersey City. When the new Dickinson High School, one of the most up-to-date structures of its kind in the country, was erected in 1904, Mr. Calahan was appointed chief engineer of the building. In 1909 he was chosen by the directors of the board as supervising engineer for the entire school system of Jersey City, a position that required thorough technical and practical knowledge. He has entire charge of the heating and ventilating systems of the schools and has proven his ability by his satisfactory service since his appointment.

He has ever had the interests of engineers and the engineering profession at heart. His influence was instrumental in obtaining for Jersey City an ordinance for the licensing of engineers—afterward made a state law—which proved a benefit to the engineer and a safeguard to the life of the community. He was elected president of the new license department of Jersey City and continued in that capacity until the ordinance became a state law.

Mr. Calahan has held every office in his local association, is past president of the New Jersey State Association, was state deputy for three terms, United States deputy six terms, chairman of the National License Law Committee at the Denver convention, and has been a delegate from the Jersey City Association to numerous other conventions. He is connected with many social societies, is a member of the American Society of Heating and Ventilating Engineers and the Alumni of the New York School of Heating and Ventilating and is a teacher in the evening classes of Power Plant Operation at the Jersey City High School. During the recent war he again offered his service to the country, this time serving as instructor for the United States Shipping Board Recruiting Service of the Merchant Marine Engineering School. The result of his efforts in this work was that all students graduating from his class did so at such percentages as to merit credit both for themselves and their instructor. Mr. Calahan has done much to advance the welfare of the National Association of Stationary Engineers in the State of New Jersey, and we wish him all the success which is merited by one who has given so generously of his time in the interest of the calling to which he has so conscientiously devoted himself.

Water-Power Development and Public Information Committee Chairmanships

President R. H. Ballard of the National Electric Light Association announces the acceptance of John F. Gilchrist, vice president of the Commonwealth Edison Company of Chicago, as chairman of the Committee on Public Information, and also of Franklin T. Griffith, president of the Portland Railway, Light and Power Co., of Portland, Ore., as chairman of the Committee on Water Power Development. These important committees will have valuable and instructive reports to submit to the national convention of 1920, which will be held in southern California.

The Committee on Public Information is a new one, and Mr. Gilchrist will organize it by establishing in each state or geographical section a local committee, which will finance itself and furnish news bulletins to the press through member companies. Recommendations for appointment as members of the general committee, of men selected as chairmen of committees in various states, will be made by Mr. Gilchrist and will be submitted for approval to the president and to be acted upon by the Executive Committee.

This will be a very large committee, but as its work will be largely devoted to states and geographical sections, it is unlikely that its entire membership will ever be called to meet. Thus its proportions will not be objectionable. Mr. Gilchrist was instrumental in starting a movement along these lines in Illinois which proved very successful. It is believed that to extend it to every state in which company members may desire assistance will accelerate its effectiveness.

The work of the Committee on Water Power Development, which will be under the direction of Mr. Griffith, who will associate with himself prominent executives from all the Pacific coast companies and also some of the executives from Eastern companies, has before it an enormous scope for its activities. The purpose of its organization is to investigate and encourage water-power development, and it is the first general committee of the association to take up this important feature of the electrical industry.

The Department of the Interior, the War Industry Board and other bodies have collected an enormous amount of data in relation to the problems of water-power development. Mr. Griffith's committee will not only collect and codify the information gathered by these bodies, putting it into workable shape for the use of geographical and central states, but will pursue, where there seems to be a necessity, a line of original investigation. The need for conservation of the natural resources of the nation, the impending shortage of both coal and fuel oil and the prob-

ability of large increases in the demand for electric energy by partial railroad electrification, make the work of this committee of paramount importance, and its report will be of great assistance in the financing which extensive water development will involve.

A Short Course for Marine Engineers

When the United States entered seriously into the shipbuilding industry and the Shipping Board began delivering vessels for cargo service at a rate never dreamed possible, a brand new difficulty confronted the board; namely, the want of properly trained officers.

This was particularly true of the propelling-machinery staff, for not only were reciprocating engineers needed in large numbers, but since an increasing percentage of vessels were being equipped with the more modern geared-turbine drive, it was necessary for the board to train men to become masters of this new class of machinery.

The solution of this problem lay in the opening of turbine schools where skilled engineers, who have been trained on reciprocating engines or had in some cases limited experience in the handling of turbines, could be given the latest and most approved instruction under the direction of men thoroughly familiar with the construction and assembling of this type of engine.

In order to accomplish this result most effectively, the board communicated with the leading manufacturers of turbines (Westinghouse, General Electric, DeLaval, Kerr and others) and proposed that classes be established at each plant for engineers who would be supplied by the Shipping Board. This proposal was promptly accepted, and the first class was opened at the Westinghouse Works, East Pittsburgh, in 1918.

The school was under the official direction of the board's recruiting service, with headquarters at Boston. The director was Henry Howard, a Boston business man and chemical engineer, who had made a life-long study of marine affairs and was serving the board for one dollar a year. After the school had been in existence a short time, it was placed under the direction of A. A. Gathemann, Supervising Engineer of Turbine Training, United States Shipping Board Recruiting Service, a man of enthusiasm and thorough training as an engineer, who deserves unlimited credit for making this undertaking the wonderful success it has become.

The students for these schools are passed upon by Mr. Gathemann and must be either chief engineers or first assistants. Many candidates apply directly to the recruiting service; others are selected from their staffs by the various ship-operating companies; still others are picked up individually by the recruiting service and the turbine manufacturers, either because of personal acquaintance or through correspondence requesting information as to turbine operation.

During the course of instruction, which averages about six weeks in length, the students receive liberal shore pay, together with traveling expenses and an allowance for sustenance. Upon completion of the course, if the student has attained a satisfactory average for all work done, he is awarded a diploma which, although it has no official status, is ample evidence that the holder is qualified to operate marine turbines. Over 250 students have so far been enrolled.

The two principal schools are located at the plants of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, and the General Electric Company, Schenectady, N. Y. All students must take the courses at both of these schools, and then those who are to handle some other make of turbine in the immediate future are transferred to the plant of that particular manufacturer.

The course at East Pittsburgh runs through a period of three weeks and is divided into five main subjects as follows: Small turbine drives; condensers and auxiliaries; main turbines; main reduction gears; and electrical equipment.

First of all, the class is taken into the shop in groups of not more than seven or eight to each instructor, and given the opportunity of seeing all parts of each piece of the various propelling apparatus. Each part is carefully and systematically shown and explained in detail. Great care is taken to explain the reasons of design, where trouble may occur and how to remedy it. The class is also given every opportunity of taking each piece of apparatus apart and reërecting it, so as to make sure they have a thorough understanding of the construction. They also have to actually go over all adjustments on the turbines and do sufficient work on the inserting of turbine blades to know what to do in the case of trouble. On the main gears great care is taken to make the class familiar with all adjustments necessary for aligning and operation.

Supplementing this, lectures are given on each of the foregoing groups in which the practical points of operation are emphasized and fundamental principles brought out. The class is encouraged in every way to ask questions during the lectures, thereby increasing the value of the lecture to a great extent.

A specified time is allotted to each subject, on the expiration of which the answers to the examination questions on that subject are to be written out and handed in. The

CLASS SETTING BLADES IN TURBINE SPINDLE

corrected examination paper is handed back to each student together with a copy of the correct answers. The student's attention is called to the questions he has not answered correctly.

The examination papers are all corrected and rated, and a careful record is kept of each student. When the course is completed, this record is forwarded to the Shipping Board, and they then have a true analysis of the student's aptitude and probable ability, which is very useful in finally placing him.

The average class consists of 16 men, usually ranging from 24 to 50 years of age. They bring to the manufacturing company years of sea experience and at times give valuable suggestions to the company's engineers. At all times they keep the company's engineers on the alert to answer their very practical questions. They are all anxious to learn the how and why of the apparatus from the inside, and make ideal students.

According to a report by the Bureau of Census, the electric light and power stations of the United States generated more than 25,000 million kw.-hr. during 1917, producing an income of $500,000,000 and employing more than 100,000 persons. The output for 1917 was more than twice that for 1912 and more than four times that for 1907. These figures do not include private generating plants, but include 4224 company stations and 2317 municipal stations. Though 2296 new establishments came into existence during the period of 1912-17, the net increase was only 1320 owing to combinations and various other changes.

N. A. S. E. Convention at Huntington

THE thirty-seventh annual convention of the National Association of Stationary Engineers was formally opened in the auditorium of the Municipal Building, Huntington, W. Va., at 10 o'clock, Tuesday morning, Sept. 2, by C. L. Humphreys, chairman. The local committee introduced Mayor C. W. Campbell, who welcomed the visitors in the name of the city and expressed the pleasure which the city felt at having been chosen as a meeting place, assuring the delegates that their comfort and enjoyment were the personal concern of every citizen. National President Roderick Mackay acknowledged the mayor's welcome in his characteristics way, stating among other things, that after Collis P. Huntington had done all he could with Huntington, W. Va., he went out to Los Angeles, where Mackay hails from, and built a regular city.

Samuel B. Montgomery, state labor commissioner, told of the resources of West Virginia in coal, oil, natural gas, timber and agricultural products.

Vice President John J. Calahan responded briefly but effectively, following which George I. Neil, ex-president of the Huntington Chamber of Commerce, spoke for that and its associated organizations.

Past National President John Wickert, in an address, emphasized the object of the association as improving, by education, the efficiency of its members and urged the importance of greater efficiency as a factor in the solution of the problems of reconstruction and the reduction of the costs of living. The war had shown, Mr. Wickert said, what could be accomplished by engineers in reducing the cost of power generation, and the efforts in this direction should not be relaxed.

The morning session was concluded by the presentation of a gavel to President Mackay by the local association.

Tuesday afternoon the president's report was read, in which it was stated that the war, the influenza and the aftermath of both had been responsible for some falling off in membership. A recommendation was made that special efforts be put forth to increase the membership of the association through the visits of deputies and national officers and as well by making meetings more attractive. It was also suggested that employers be made honorary members in order that their influence might be available to encourage the attendance of their engineers at all association meetings.

The question of amalgamation with the Canadian Association of Stationary Engineers was brought up by the president, who asked for instructions concerning the appointment of a committee to consider such a step. A legal contract with the National Exhibitors Association was recommended whereby the N. A. S. E. could require an accounting from the exhibitors' association for the purpose of turning over of a stipulated amount of the net proceeds to the N. A. S. E. for entertainment purposes or for any other legitimate expenses, and probably a further percentage for a sinking fund. It also was suggested that a representative of the N. A. S. E. should be placed on the board of directors of the National Exhibitors Association to watch and guard their interests, and the president asked that he be empowered to appoint a committee for this purpose. The resolution was adopted unanimously.

There had been some infractions of Article 21 of the constitution, which prohibits local associations from soliciting advertisements for any other than the association's official paper. These infractions had been dealt with by suspension or reprimand, and any complaint at such punishment was considered by the president to be "poor taste on their part."

National Deputy John J. Calahan urged more interested response from the local associations, the lack of which prevented him from making complete statistical reports. A resolution calling for state organizers was referred to the committee on resolutions. The spirit of the times was reflected in several resolutions intended to amend the preamble of the constitution, eliminating the clause containing the declaration that "this association shall at no time be used for the furtherance of strikes." The resolution, however, failed of adoption.

The secretary's report showed an active membership of 16,380, of which number 272 delegates were reported present by the credentials committee. Including the honorary and associate members, and those who are one year or less in arrears, the total membership would be 20,178. The treasurer's report showed the association to be in good financial condition.

It was recommended by the educational committee that in view of the limited use of lantern slides, no extensive additions are to be made during the coming year to the educational program. It was further recommended that a bulletin be issued on the use and value of exhaust steam and that the question and answer department be continued.

The license committee reported that there has been very little sentiment for license legislation manifested by the organization during the past year. Bills were presented in the legislatures of West Virginia, Illinois and Iowa, none of which was successful. It was reported that Kenosha, Wis., has adopted an ordinance providing for the licensing of stationary engineers.

Tuesday afternoon a paper on national water power conservation, by Thomas J. Royer, of Los Angeles, Cal., was presented in his absence by H. R. Hilton.

Wednesday morning, John Lane, editor of the National *Engineer*, the official publication of the association, presented some thoughts on the shortening of the distance from the engine room to the office. Walter N. Polakov read a paper on a two-rate wage, which proposes a living wage for every worker, irrespective of his efficiency, and an additional wage proportioned to the service rendered. Mr. Polakov stated that the power plant, in which efficiency of service is easy of determination, offers excellent opportunity for the application of such a theory.

Wednesday afternoon was given over to a program of sports at Camden Park.

Thursday, a resolution was made and adopted calling for a joint committee of the N. A. S. E. and the Exhibitors' Association to consider the next meeting place. A resolution providing for junior members is to be submitted to referendum.

There was much discussion regarding getting back ex-members and increasing of the membership. Mr. Cook, president of the Canadian Association of Stationary Engineers, returned the official visit of Secretary Raven, and briefly addressed the meeting.

The following papers were read during the afternoon: "Power Plant Costs," by J. J. McGowan; "Relations of Consulting and Operating Engineers," by Charles A. Cahill, followed by a topical discussion on the details of operating routine in power plants.

The award of flags to associations showed marked gain in membership, Detroit No. 7 receiving first place with 58 new members. A reception followed by the ladies' auxiliary, speeches being made by Mesdames Mullin and Amer. One hundred dollars was voted for the auxiliary and three hundred dollars additional to the salary of the treasurer of the Association.

Thursday evening, entertainment was provided by the Exhibitors' Association.

The Exhibitors' Association elected the following new officers: Horace A. Smith, Philadelphia Grease Co., president; F. N. Chapman, A. Leschen & Sons Rope Co., vice president; A. W. France, France Metallic Packing Co., treasurer; Frank Martin, Jenkins Brothers; Hudson Dickerman, John S. Pratt Co.; W. M. Rand, Ashton Valve Co.; W. L. Schaeffer, National Tube Co., and Chas. McDonald, Allis-Chalmers Co., members Executive Committee.

The national officers for the ensuing year were elected on Friday and are as follows: President, John J. Calahan, Jersey City, N. J.; vice president, Alfred Johnson, Chicago, Ill.; secretary, F. W. Raven, Chicago, Ill.; treasurer, Samuel B. Forse, Pittsburgh, Penn.; conductor, Eugene L. Kissel, Portland, Ore.; chairman board of trustees, H. J. Mistele, Milwaukee, Wis.

The next convention will be held in Milwaukee, Wis.

Coal Meter for Chain-Grate Stokers

To determine the amount of coal consumed by an individual boiler is a comparatively simple matter, but with a battery of boilers, fuel delivered irregularly, and with a large quantity always in stock, it is difficult to ascertain with accuracy how much coal has been consumed per day, or week, unless weighing machines or measuring appliances

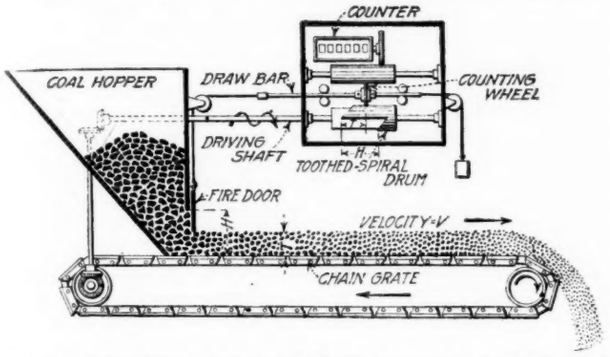


FIG. 1. SHOWING ARRANGEMENT OF COAL METER FOR BOILER FURNACE

are provided. The Lea Recorder Co., Ltd., 28 Deansgate, Manchester, says *The Engineer*, has placed on the market an appliance specially intended for boilers fitted with chain grates, which works much upon the same lines as the well-known V-notch recorders and integrators for water measurement. Its action is based on the theory that when coal is supplied to a boiler by means of a chain-grate stoker the amount of fuel passing under the fire-door may be regarded as a stream with a constant width, but the depth and velocity of the stream are subject to variation. The width of the stream is the width of the chain grate, the depth is the thickness of the fire, and the speed is the rate of travel of the chain grate. Therefore: If W = the width of the stream in feet, T the thickness or depth in feet, and V the velocity of the stream in feet, per hour, then,

$$\textit{cubic feet per hour} = W \times T \times V = \textit{cross-sectional area} \times V$$

Although slack and small coal are not perfectly homogeneous and do not obey the laws of fluids or mathematics exactly, it has been found by experience that under ordinary conditions of working the flow of coal under a fire-door is, generally speaking, proportional to the thickness of the fire and to the velocity of the grate, and that the results are consistent with what might be expected, theoretically. As the width W is constant, and T and V are the only variables, all that is required is some form of automatic integrating mechanism which will at all times take into account the two items T and V, and this is what the inventors claim that the Lea recorder actually does. As will be seen from the diagram, Fig. 1, the motion of the grate is transmitted by gearing to a spirally toothed drum, Fig. 2, the pitch of the teeth of which is equal, or proportionate to, the maximum lift of the fire-door, or the thickness of the fire H, Fig. 1. A toothed counting wheel, Fig. 2, gearing with the spiral drum below, and with a counting box above, is mounted on a rod, or drawbar, directly connected with the fire-door, and as the latter is opened or closed, the counting wheel is moved to and fro laterally across the spiral drum, which causes the wheel to revolve, more or less, according to its lateral position. Assuming, for instance, an 8-in. fire to be the maximum, with that thickness of fuel the counting wheel will engage with all the teeth of the drum; with a 4-in. fire the counting wheel will only engage with a half of them, and if the fire-door is shut the counting wheel and drum will not engage. Therefore, it is claimed that for all variations in the thickness of the fire or in the speed of the grate, the number of revolutions of the wheel will be proportional to the total cubic feet of coal that is passed; and by means of proper constants for the units shown on the counting dials, the total quantity either in cubic feet, tons, or pounds can be determined pretty closely.

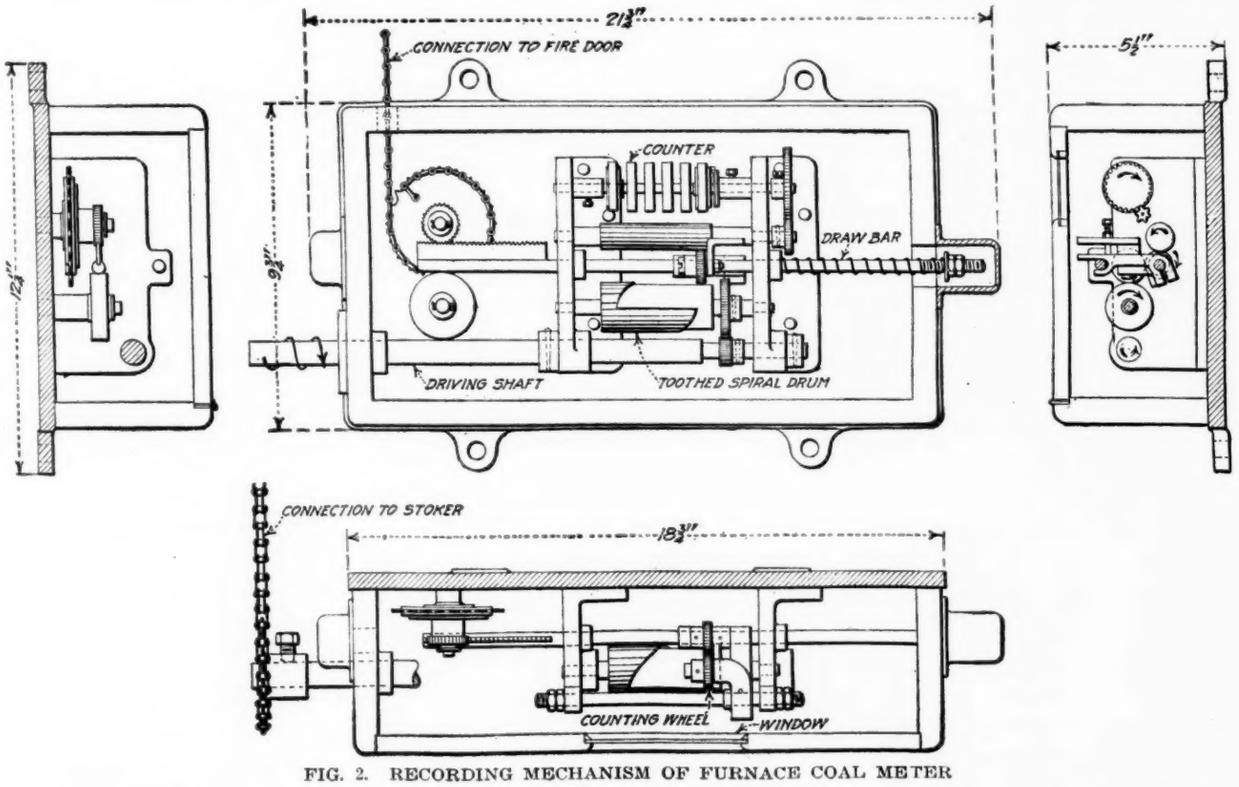


FIG. 2. RECORDING MECHANISM OF FURNACE COAL METER

The determination of the unit used can be done readily by measuring out upon the boiler-room floor a certain number of cubic feet of coal, passing it through the stoker and noting the number of units recorded by the meter. In this connection it is frequently supposed that there are great differences in the weights of small coals for given

cubic capacity, on account of the variation in the size of the fuel. This is not borne out either by experience or mathematically. The weights of equal volumes of spherical bodies of different diameters, but of the same specific gravity, are all exactly the same. The percentage of interstices is quite independent of the diameters of the individual spheres, provided, of course, that the size of the containing vessel is reasonably large as compared with that of the material itself. In other words, a cartload of "nuts" of uniform grade weighs approximately the same as a similar load of pea coal.

The mechanism is all inclosed and the apparatus occupies very little space, and need not of necessity be attached to the boiler itslf. It is easily read, requires no skilled attention, and the wearing parts are few. The makers give a guarantee of accuracy to within 5 per cent.

A cylinder rate table for internal-combustion engines has been prepared for use in connection with writing-machinery breakage insurance. This table will be part of the new Steam Boiler and Engine Manual, no previous rates of this kind having been promulgated. The internal-combustion engine table gives the three-year rates for a policy bearing the standard internal-combustion-engine indorsement which must specifically exclude liability for the replacement or renewal of ignition tubes, spark plugs or other igniting apparatus, vaporizers and rubber parts of gas bags. For oil engines of the Diesel type the cylinder rates shall be double the rates shown in the table for the corresponding diameters. To determine the rates for a double-acting internal-combustion engine of any type, assume a single-acting engine of the same type but twice the number of cylinders; then compute the rate in the regular way for the assumed engine.—*Eastern Underwriter.*

During the war an Italian engineer named Adolfo Pouchain, after a series of experiments, succeeded in producing a new alloy of zinc and copper which has been given the name of "Biakmetal." Its most important characteristics are stated as follows: (1) The highest known breaking point; (2) the highest limit of elasticity; (3) perfect homogeneity; (4) high resistance to thermic action and (5) high resistance to chemical action. It is said to be extremely well adapted for almost any kind of manipulation. It can be successfully cast, turned, drawn, rolled, forged and stamped. In its different forms it can be substituted for steel, brass and aluminum.—*Commerce Report.*

Flywheel-insurance rate factors have been revised downward, it having been decided that the present rates are too high on renewals. This revision makes a reduction of much over 100 per cent. on the smaller sizes and up to the neighborhood of $50,000 insurance on a single accident. Above that figure the rates have been materially increased, the advances reaching 100 per cent. in some cases. As there are few coverages over $50,000, the increases in rate factor will not materially affect much of the business, but the ordinary risk will benefit by substantial reductions.—*Eastern Underwriter.*

There are 200 engineering societies in the United States with a total membership of 100,000, the annual dues amounting to about $1,000,000. There are possibly 200 other societies more or less connected with engineering and having many engineers as members. Probably 100,000 other engineers do not belong to any society.—*Compressed Air Magazine.*

Peanuts are said to contain from 38 to 50 per cent. of oil, and pods 4 to 5 per cent. This oil can be successfully burned in Diesel engines, and it may prove a valuable source of fuel in localities where petroleum oils are scarce, such as in the interiors of tropical and semi-tropical countries.—*The Gas Engine.*

During the daylight saving season last year, the Edison Electric Illuminating Co., of Boston, saved 4420 long tons of coal. The decrease in kilowatt-hours from this cause was 5,000,000, representing a loss in revenue of about $350,000.—*Compressed Air Magazine.*

New Publications

TESTS OF WIRE ROPE

Bulletin No. 121, issued by the Bureau of Standards of the Department of Commerce gives a digest of the result of tests of 275 wire ropes submitted by American manufacturers to fulfill the specifications of the Isthmian Canal Commission. The ropes, which were selected by Government officials, were from ½-in. to 1½-in. in diameter, a few being of larger diameters up to 3¼-in. Over half the specimens were plow and crucible cast-steel hoisting rope of 8 strands of 19 wires each, the remainder being guy and tiller ropes of 6 strands of 7 wires and 6 strands of 42 wires each. Tables of results are given, illustrating the tensile strength of specimens of different diameters. The results of tests of the quality of material used, torsion and bending tests of wires and the cumulative elongations, and reductions in diameters of cables are shown. This bulletin is now ready for publication, and those interested may obtain a copy by addressing a request to the Bureau.

Personals

G. T. Hungerford, formerly New York City sales manager of the Files Engineering Co., Inc., Providence, R. I., is now general sales manager.

The Manternach Co., Hartford, Conn., has opened an office in the Morgan Building, Buffalo, with Walter A. Allen, secretary of the company, in charge.

Fred Gebbauer has been appointed special Navy Yard representative of the Chicago Pneumatic Tool Co., with headquarters at the company's Philadelphia office at 1740 Market St.

D. J. Kerr, electrical engineer at the Champion Fibre Co.'s Canton (N. C.) plant, has been made superintendent of the power department in connection with the electrical department.

Cedric B. Smith has been appointed editor of "The Monad," the official organ of the American Association of Engineers. Mr. Smith was until recently in the employ of the Pennsylvania lines in Pittsburgh.

J. J. Brown, formerly vice president and general manager of the Wheeler Condenser and Engineering Co., Carteret, N. J., was recently elected president of the company to succeed Charles W. Wheeler, deceased.

A. A. Schneider, formerly with the raw materials department of the Midvale Steel and Ordnance Co. and Cambria Steel Co., has been appointed manager of the newly created raw materials division of the American Steel Export Co.

Col. Peter Junkersfeld, who, upon returning to civilian work early this year, resigned as assistant to the vice president of the Commonwealth Edison Co. to become engineering manager of Stone & Webster, has been awarded the distinguished service medal for his work during the war.

P. K. Condict, vice president of the International Western Electric Co., has been awarded the fourth order of merit with the Rising Sun through the Japanese Minister of Communications. This honor has been conferred upon Mr. Condict for services rendered in supplying materials necessary for the extension of the telephone system of Japan.

Wiliam G. R. Braemer, formerly president of the Braemer Air Conditioning Corp., has resigned to engage in active professional practice as a consulting engineer, with offices in the Stephen Girard Building, Philadelphia. Mr. Braemer was for many years chief heating and ventilating engineer for the Buffalo Forge Co., of Buffalo, N. Y., and later was official advisor and assistant of Warren Webster & Co., Camden, N. J.

L. E. Strothman, who for several years has been manager of the steam turbine and pumping engine departments of the Allis-Chalmers Manufacturing Co., and prior to that was connected with the Filer & Stowell Co. and the Nordberg Manufacturing Co., has resigned to become vice president and general manager of the Richardson-Phenix Co. Mr. Strothman is well known in manufacturing circles as well as in the various professional engineering societies. In making the change J. Wm. Peterson has become president and treasurer of the Richardson-Phenix Co.

Engineering Affairs

The New England Section, N. E. L. A., will hold its anual convention in New London, Conn., Sept. 22-24, and not Sept. 16-18, as reported in last week's issue.

Miscellaneous News

The Empire State Gas and Electric Association will hold a meeting in Buffalo Oct. 24.

An Electrical Show will be held in Buffalo from Oct. 16-25. This will be the first electrical show held in that city since March, 1914.

The American Boiler Manufacturers' Association will hold a meeting at the Hotel Astor, New York City, Sept. 24. The subject of "Boiler Costs' will be discussed.

The Joint Commission on Reclassification of Salaries, created by the Sixty-fifth Congress, instructed to investigate the rates of compensation paid to civilian employees by the municipal government and other government establishments in the District of Columbia, is engaged in making a preliminary classification. The Washington Chapter of the American Association of Engineers is securing information relative to the salries of technical men included within the scope of the investigation the commission is authorized to make, and making recommendations as to the revisions which should be made. The actual preparation of the commission's report is being made by Arthur Young & Co., efficiency engineers.

Business Items

The Goulds Manufacturing Co., Seneca Falls, N. Y., will open a district sales office in the Dime Bank Building, Detroit, Mich., on Sept. 1, with E. B. Gould in charge.

The Dickey Steel Co., Inc., Woolworth Building, New York City, has been appointed sales representative for the New York and Philadelphia district of the Worcester Pressed Steel Co., of Worcester, Mass., manufacturer of hot and cold rolled strip steel, and light and heavy metal stampings.

Trade Catalogs

The L. J. Wing Manufacturing Co., New York City, has issued a 16-page bulletin No. 58, which illustrates and gives some useful general information on "Scruplex Fans and Exhausters."

The **Wellman-Seaver-Morgan Co.,** Cleveland, Ohio, has issued bulletin No. 27, which describes and illustrates W-S-M automatic ore unloaders on the Great Lakes. A copy of the bulletin may be had free upon request.

S. F. Bowser & Co., Inc., Fort Wayne, Ind., has issued a little folder which illustrates and describes a Bowser battery storage system for lubricating oil. It shows how tanks of varying capacity may be placed in battery, all of uniform height.

The Worthington Pump and Machinery Corp. has acquired the entire plant and other properties of the Epping-Carpenter Pump Co., of Pittsburgh, Penn., to which all correspondence should hereafter be addressed.

The Mesta Machine Co., Pittsburgh, Penn., has published Bulletin S, containing 32 pages on "Mesta Auxiliary Equipment for Rolling Mills," illustrating and describing the most modern machinery for rolling mills. Copies of the bulletin will be sent free upon request.

The Weber Chimney Co., Chicago, Ill., has issued a new 54-page catalog, No. 19, on "Weber Chimneys," which illustrates and fully describes these chimneys, method of construction, etc., including that of the highest chimney in the world, built in Japan. Copy may be had free upon request.

The Fisher Governor Co., Inc., Marshalltown Iowa, has issued a 94-page catalog, T-19, on "Fisher Steam Traps," type No. 33. It is a very complete, detailed and comprehensive trap catalog, and the illustrations alone convey an excellent idea of the merits of this trap. Some suggestive illustrations are shown on the last few pages.

The Diamond Power Specialty Co., Detroit, Mich., has issued its 24-page bulletin No. 132, entitled "Profits That Get Away Through Your Boiler Room." It deals with the importance of exercising business-like supervision over the boiler room; the effect of soot on boiler efficiency and also describes Diamond soot blowers for horizontal return tubular boilers. Copy free upon request.

The Allis-Chalmers Manufacturing Co. announces a new line of commutating pole direct-current motors and generators designated as Type E. The machines are rugged and compact and have excellent operating characteristics. The many details which contribute to accessibility, reliability and safety have been thoroughly worked out. This line includes the following standard ratings: 1, continuous rated (50 deg. C. rise) motors, for applications where the power requirements are definitely known; 2, normal rapid (40 deg. C. rise) general purpose motors; 3, adjustable speed motors for continuous or intermittent service; 4, generators and exciters. For constant speed motors the ratings and speeds are the same as those of 60-cycle induction motors, and they can thus be used interchangeably with induction motors for direct connected applications without changing the method of drive or the ratio of gearing. Adjustable speed motors, intended particularly for machine tool and similar applications are provided for 2:1 or 4:1 speed range. Generator speeds also correspond to those of induction motors, thus permitting the direct coupling of the machines to form motor-generator sets in various combinations. The line of ratings now complete covers motors from ½ to 50 hp. and generators from ½ to 40 kw., while larger sizes are under development. These machines are described in Bulletin No. 1106.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.00	$3.00@3.50
F. o. b. Philadelphia, gross tons	4.79@5.25	5.20@5.70
F. o. b. New York, gross tons	5.10@5.60	5.50@6.00
Alongside Boston (water coal), gross tons	6.85@7.85	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.00@6.50 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.30	$7.05
Egg	6.35	8.20	Buckwheat	3.40	5.15
Stove	6.60	8.45	Rice	2.75	4.50
Chestnut	6.70	8.55	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.70@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@2.90
Reynoldsville	2.70@2.90
Quemahoning	3.25@3.50
Somerset (medium)	3.10@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.65@2.75
Fairmont	2.50@2.65
Latrobe	2.75@2.90
Greensburg	2.75@3.00
Westmoreland ¾ in.	3.50@3.75
Westmoreland run-of-mine	3.20@3.35

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Anthracite Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.35	8.20	Rice	2.75	3.65
Stove	6.60	8.45	Boiler	2.50	3.50
Nut	6.70	8.55	Barley	2.25	3.15
Pea	5.30	6.90			

PITTSBURGH—Counting out occasional low and high priced sales involving but small tonnage, the great bulk of the transactions is quotable as follows, Pittsburgh District:

Steam:	Per Net Ton
Slack	$2.10@2.30
Mine-run	2.50@2.60
Gas:	
Slack	2.20@2.40
Mine-run	2.50@2.70
Prepared sizes	2.60@2.90

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.25	$2.60	$2.40
Black Creek and Cahaba	3.25	3.45	3.05
Jagger - Pratt Corona	2.85	3.00	2.45
Blacksmith	....	5.25	....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	5.00@$5.50
Corona	3.50
Jagger	3.50
Montvallo	5.50@$6.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$3.25	$2.55	$2.75
Mine run	2.40*@2.60	2.35	2.00@2.20
Screenings	2.10*@2.30	2.05	2.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rates $0.92½.

New Construction

PROPOSED WORK

Conn., Bridgeport—Fletcher-Thompson, Inc., Engr., 1089 Broad St., will receive bids about September 20 for the construction of a 7 story, 100 x 140 ft. cold storage building on Seaview Ave., for the Peoples Ice & Cold Storage Co., 1335 Seaview Ave.

N. Y., Corona—The Sheer's Amusement Co. will build a 1 story theatre on Continental and Queens Blvds. A steam heating system will be installed in same. Total estimated cost, $100,000. Work will be done by day labor.

N. Y., Long Island City—The Lehigh Silk Hosiery Co., 220 5th Ave., New York City, will soon award the contract for the construction of a 7 story factory here. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Ballinger & Perrott, 47 West 34th St., New York City, Engr. and Arch.

N. Y., New Rochelle—D. W. Griffith, 1476 Broadway, New York City, will build a 1 story, 150 x 200 ft. studio here. A steam heating system will be installed in same. Total estimated cost, $500,000. Work will be done by day labor, under supervision of Russel B. Smith, Engr., 50 East 42nd St., New York City.

N. Y., New York—The Board of Education, 500 Park Ave., is having plans prepared for the construction of a 5 story, 59 x 112 ft. school at 201-207 Hester St. A steam heating system will be installed in same. Total estimated cost, $375,000. C. B. J. Snyder, Municipal Bldg., Engr.

N. Y., Walton—The J. Kayser Co., 32nd St. and Madison Ave., New York City, is having plans prepared for the construction of a 1 story factory, here. A steam heating system will be installed in same. Total estimated cost, $100,000. William Higginson, 18 East 41st St., New York City, Engr. and Arch.

N. J., Union—The Board of Education will receive bids September 18, for the installation of heating and ventilating systems in new school here. G. J. Bieling, Pres.

N. J., Union Hill—The Board of Education will soon award the contract for furnishing and installing heating and ventilating systems, plumbing, vacuum cleaner, etc., in the proposed new school building on 1st St. and Hudson Ave. Total estimated cost, $250,000. Noted Feb. 18.

Pa., Bath—The Pennsylvania Cement Co. plans to install power plant and waste heat boiler, at their mill here. The Republic Engineers, Inc., 60 Broadway, New York City, Engr.

Pa., Chester—Nixon & Nirdlinger, 16th and Walnut Sts., are having plans prepared by H. C. Hodgens, Arch., 130 South 15th St., for the construction of a 1 story, 150 x 180 ft. theatre and store building. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., New Brighton—The Board of Education is receiving bids for the construction of a 3 story, 91 x 135 ft. and a 2 story, 82 x 98 ft. high school, on Pierce and East 4th Sts. Hot air system with fan will be installed in same. W. G. Eckles, New Castle, Arch.

Fla., New Port Richey—The city plans to install an electric light and ice making plants.

Ohio, Greenville—The town voted $45,000 bonds to build waterworks and electric light plant.

Mich., Detroit—The Board of Education, 50 Broadway, received bids for the installation of heating, ventilating and plumbing systems in proposed Nichols School, on Burns and Goethe Ave. from M. B. O'Connor, Penobscot Bldg., $42,025; R. L. Stitzler Heating Co., 403 Vinton Bldg., $51,777; A. W. Schultze Co., 815 Gratiot Ave., $54,605; in proposed Ellis school, from A. W. Schultze & Co., 403 Vinton Bldg., $36,927, and in proposed Condon School on Buchanan and Vinewood Ave., from M. B. O'Connor, Penobscot Bldg., $48,996; A. W. Schultze Co., 815 Gratiot Ave., $58,608. Noted Aug. 26.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has had plans prepared for the construction of a 2 story, 25 x 113 ft. electric sub-station, at Connor's Creek, near Six Mile Rd. Estimated cost, $40,000.

Mich., Detroit—The Michigan Machine Co., 16th and Porter St., is having plans prepared for the construction of a 3 story, 107 x 158 ft. factory. Steam heating system and electric motors for power will be installed in same. Total estimated cost, $150,000. Brown & Preston, 406-8 Empire Bldg., Arch.

Mich., Grand Rapids—The Grand Rapids Tuberculosis Hospital is having plans prepared for the construction of a 4 story, 50 x 170 ft. main building, 2 story, 50 x 100 ft. nurses home, and a 70 x 70 ft. power plant to include 2 steam units each 300 hp. Total estimated cost, $400,000. Robinson & Campau, Grand Rapids, Arch.

Mich., Jackson—W. W. Bradfield, Engr., and H. L. Mead, Arch., both of Grand Rapids, are receiving bids for the construction of a 5 story, 123 x 265 ft. factory here, for the Michigan Seating Co., East Washington St. Steam heating and power equipment will be installed in same.

Mich., Saginaw—Cooper & Beckbissinger, Arch., 114 South Jefferson St., are preparing plans for the construction of a 4 story, 100 x 120 ft. factory here. Steam heating equipment will be installed in same. Owner's name withheld.

Ill., Chicago—Wilson Jones Loose Leaf, 3021 Carroll Ave., will soon award the contract for the construction of a 2 story, 250 x 400 ft. stationers' supply factory on Ohio St. and Spaulding Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. L. G. Hallberg & Co., 116 South Michigan St., Arch. Noted Aug. 26.

Ill., Waterloo—The Waterloo Condensed Milk Co. wants a refrigerating apparatus and one or two boilers.

Minn., Hibbing—The city will soon award the contract for the construction of a 2 story, 135 x 251 ft. recreation building on 1st Ave. and Jackson St. A steam heating system will be installed in same. Total estimated cost, $350,000. Holstead & Sullivan, Palladio Bldg., Duluth, Engr. and Arch.

Minn., Rochester—A. Fawcett, Rochester, will receive bids until September 20, for the construction of a 5 story, 46 x 142 ft. dental building. Steam heating and electric light system will be installed in same. Total estimated cost, $300,000. F. M. Mann, Metropolitan Life Bldg., Minneapolis, Arch.

Kan., Oswego—The city will soon award the contracts for furnishing and erecting the following equipment: 1 internal combustion engine of 200 hp. capacity, direct connected to a 150 K V A. generator; 1 internal combustion engine of 150 hp. capacity direct connected to 125 K V.A. generator; exciters complete for generators; 1 four panel switch board erected complete; air tanks, air starters, gasoline tanks, and all piping for engine to be furnished and installed; furnishing all foundations for machines under another contract; furnishing all material and wiring power house and making all electric connections from generator and switchboard. Noted February 4.

Mo., St. Louis—The Blackwell Wielandy Stationery Co., 16th and Locust St., will soon award the contract for the construction of a 7 story, 90 x 150 ft. mercantile building. Heating and sprinkling equipment will be installed in same. Total estimated cost, $350,000.

Mo., St. Louis—Herman Kaupe, 3009 McNair Ave., is in the market for a 14 h.p. alternating current motor.

Mo., St. Louis—The Pan-Electric Manufacturing Co., 735 South 4th St., is in the market for a 75 to 100 h.p. boiler.

Tex., Fort Worth—The Ok-in Producing & Refining Co. will soon receive bids for steel tankage and water tube boilers in connection with the proposed refinery.

Okla., Nowata—The city is having plans prepared by Burns & McDonald, Engr., Interstate Bldg., Kansas City, Mo., for waterworks and electric light improvements.

Okla., Ponca City—The city voted $50,000 bonds to build electric light plant.

Okla., Sapulpa—The Southern Ice & Utilities Co. plans to build a 2 story, 50 x 150 ft. cold storage plant, on Main St. Estimated cost, $25,000.

Wash., Seattle—J. D. Hull, Coleman Bldg., is in the market for a generator set.

Ariz., Chandler—The Trustees of Chandler School District will soon receive bids for the construction of a 2 story high school. A plenum heating and ventilating system will be installed in same. Total estimated cost, $125 000. Allison & Allison, Hibernian Bldg., Los Angeles, Cal., Arch.

Ont., London—The Utilities Commissioners, Hydro Offices, will soon award the contract for the erection of a substation and installation of transformers. Total estimated cost, $10,000. E. V. Buchanan, Hydro Offices, Engr.

Ont., Toronto—The Canadian General Electric Co, King and Simcoe Sts., plans to construct a 6 story, 50 x 200 ft. storehouse and office building, on King St. W. A vacuum steam heating system will be installed in same. Total estimated cost, $200,000.

CONTRACTS AWARDED

Mass., Lowell—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of a 1 story, garage and a 1 story warehouse on Main & Canada St. here, to H .D. Best, 949 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

N. Y., Bronx—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the installation of a heating and ventilating apparatus in P. S. No. 57, Crotona and Belmont Ave., to E. Reutzler Co., 404 East 49th St., New York City, $115,712. Noted Sept. 9.

N. Y., S. I., Dongan Hills—The Board of Education, 500 Park Ave., New York City, has awarded the contract for the construction of P. S No. 11, Jefferson Ave. between Cromwell and Carretson Ave., to J. MacArthur, 120 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $180,000.

Pa., Philadelphia—The Hale & Kilburn Corporation, 18th and Lehigh St., has awarded the contract for the construction of a 5 story, 196 x 260 ft. factory, on 16th and Glenwood Sts., to H. E. Baton, 1713 Sansom St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Pa., Williamsport—The Board of Education has awarded the contract for installing a steam heating system in connection with the proposed 3 story, 100 x 120 ft. school building on Wayne Ave., to F. Keeler Co., 238 West St., Williamsport, $49,534.

N. C., Nashville—Nash County has awarded the contract for heating and plumbing in the proposed new courthouse here, to W. W. Dick, Greenboro. Estimated cost, $15,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Road, has awarded the contract for the construction of a 1 story, 192 x 238 ft. factory, at 1040 Ivanhoe Road, to the Honkin Conkey Co., Century Bldg., Cleveland. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Flint—The General Motors Corporation, 435 Woodward Ave., Detroit, has awarded the contract for the construction of a 7 story, 214 x 280 ft. recreation building here, to Thompson-Starrett Co., Lincoln Bldg., Detroit. Steam heating equipment will be installed in same. Total estimated cost, $2 300,000.

Mich., Pontiac—The General Motors Truck Co. has awarded the contract for the construction of 3 story, 80 x 300 ft. warehouse, to W. E. Wood & Co., Ford Bldg., Detroit. Steam heating apparatus and freight elevators will be installed in same. Total estimated cost, $100,000.

Wis., Sheboygan—The Bemis Riddel Co., South Water St., has awarded the contract for the construction of a factory, to the Prange Guessenhainer Co., North 8th St. A steam heating system will be installed in same. Total estimated cost, $11,900.

Kan., Wichita—The Board of Education has awarded the contract for the installation of heating and plumbing systems in Mark Twain school, 3 story, 103 x 182 ft., to the McMahon Heating & Plumbing Co., Kansas City, Mo. Estimated cost, $41,500.

Ore., Portland—The Oregon Casket Co., 101 North 5th St., has awarded the contract for the construction of a 2 story factory on 21st and Raleigh St., to the Dinwiddie Construction Co., Yeon Bldg. Plans include 4 dry kilns, boiler house and shed. First unit will cost $175,000, ultimate cost, $350,000.

Cal., Los Angeles—The Board of Public Works has awarded the contract for the construction of a concrete sewage pumping pit, on Manchester Ave., to John F. Elee, 501 Stimson Bldg. Estimated cost, $12,000. Noted Aug. 26.

Cal., Torrance—The Southern California Edison Co., Edison Bldg., Los Angeles, has awarded the contract for the construction of a 3 story, 54 x 142 ft. sub-station, to K. R. Bradley, 1925 East 16th St., Los Angeles. Estimated cost, $60,000.

Ont., Brantford—The Slingsky Manufacturing Co., Ltd., 270 West Mill St., has awarded the contract for the 3 story, 60 x 100 ft. addition to mill, and new 4 story, 50 x 80 ft. dye house, to P. H. Secord & Son, 133 Nelson St. A steam vacuum system will be installed in same. Total estimated cost, $200,000.

Ont., Hamilton—The Board of Education has awarded the contract for the construction of a 2 story school, to W. H. Cooper, Clyde Bldg. Steam heating system with fan ventilation will be installed in same. Total estimated cost, $100,000.

Ont., Toronto—Loew's Theatre Syndicate, 1942 Broadway, New York City, has awarded the contract for the construction of a 2 story, 140 x 225 ft. vaudeville theatre, on Yonge St., here, to P. H. Secord & Son, 133 Nelson St., Brantford. An oil heating system will be installed in same. Total estimated cost, $300,000.

Ont., Toronto—The Panlages Theatres Ltd., Adelaide St., has awarded the contract for the construction of a 2 story, vaudeville theatre, on Victoria St., to Jackson Lewis & Sons, Bell Telephone Bldg. An oil heating system will be installed in same. Total estimated cost, $600,000.

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See Pages 73 to 83

See Pages 73 to 83

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire	50-Ft. Lengths
Underwriters' 2½-in.		75c. per ft.
Common, 2½-in.		40%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.50	$0.33	$0.22

Steam—Discounts from List

First grade..... 30% Second grade..... 40% Third grade....45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 65% Best grade..... 35%
Standard..... 50%

Note—Above discounts apply on new list issued July 1.

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	45%	35%
St. Louis	40%	30%
Chicago	45%	40%
Birmingham	35%	30%
Denver	35–5%	30%

RAWHIDE LACING—20% for cut; 45c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$0.90
Asbestos for high-pressure steam	1.50
Duck and rubber for piston packing	1.00
Flax, regular	1.20
Flax, waterproofed	1.60
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1.10
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.20
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05
85% magnesia high pressure			List
For low-pressure heating and return lines		4-ply	58% off
		3-ply	60% off
		2-ply	62% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	5½	6.7	8½	14½
Fiber or sponge	8	10	6	13	9	18
Transmission	7	9	6	13	7½	17
Axle	4½	6	4	4.75	3–4	5½
Gear	4½	9	4½	7.5	5½	8
Car journal	22(gal.)	21 (gal.)	3½	4.7	6½	8

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11.00 to 13.00	14.00	11.00 to 14.00
Colored mixed	9.00 to 12.00	8.50 to 12.00	11.00	9.50 to 12.00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13½ x 13½	13½ x 20½
Cleveland	$52.00	$58.00
Chicago	41.00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Cleveland	Chicago	
	Current	One Year Ago	Current	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$2.15	$1.86	$2.50	$2.48	$1.97
5-gal. cans	2.28	1.96	2.75	2.68	2.17

WHITE AND RED LEAD—Base price per pound:

	Red				White	
	Current		1 Year Ago		Current	1 Yr. Ago
	Dry	In Oil	Dry	In Oil	Dry and In Oil	Dry and In Oil
100-lb. keg	13.00	14.50	14.00	14.50	13.00	14.00
25- and 50-lb. kegs	13.25	14.75	14.25	12.75	13.25	14.25
12½-lb. keg	13.50	15.00	14.50	15.00	13.50	14.50
1-lb. cans	16.00	17.50	.....	.....	16.00	17.00
5-lb. cans	15.00	16.50	.....	.....	15.00	16.00

100 lb. lots less 10% discount; 2000 lb. lots less 10–2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅜ and smaller	50–10%	60%	55%
Tinned	50–10%	60%	55%

Boiler rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York....$4.72 Cleveland...$4.00 Chicago ...$4.87 Pittsburgh...$4.20

Structual rivets, same sizes:

New York....$4.82 Cleveland...$4.10 Chicago...$4.97 Pittsburgh...$4.30

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$80–90	at Chester, Penn.
Chrome cement	net ton	45–50	at Chester, Penn.
Clay brick, 1st quality fireclay	net ton	35–45	at Clearfield, Penn.
Clay brick, 2nd quality	net ton	30–35	at Clearfield, Penn.
Magnesite, dead burned	net ton	32.50	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–90	at Chester, Penn.
Silica brick	net ton	41–45	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.
Birmingham—Silica, $48; fire clay, $42; magnesite, $85; chrome, $85.
Chicago—Second quality, $25 per ton.
Denver—Fire clay, $11 per ton.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	125.00	80.00	108.00	60.00	100.00
Commercial	50.00	70.00	18.50	23.00	13.00	24.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21–26	$19.00
Cleveland	20.00	20.00
Chicago	16.50	19.00

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

POLES—Prices on Western red cedar poles:

	New York	Chicago	Denver	San Francisco
6 in. by 30 ft.	$5.82	$5.17	$4.55	$5.17
7 in. by 30 ft.	7.65	6.85	6.10	6.85
7 in. by 35 ft.	11.10	10.00	8.95	10.00
8 in. by 35 ft.	12.65	11.35	10.10	11.35
7 in. by 40 ft.	12.85	11.50	10.20	11.50
8 in. by 45 ft.	18.90	16.90	15.00	16.90
8 in. by 50 ft.	22.65	20.30	18.00	20.30

10c. higher freight rates on account of double loads.
For plain pine poles, delivered New York, the price is as follows:

10-in. butts, 5-in. tops, length 20-30 ft	$9.00
12-in. butts, 6-in. tops, length 30-40 ft	11.50
12-in. butts, 6-in. tops, length 41-50 ft	12.50
14-in. butts, 6-in. tops, length 51-60 ft	21.00
14-in. butts, 6-in. tops, length 61-71 ft	23.50

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Steel Inches	Steel Black	Steel Galvanized	Iron Inches	Iron Black	Iron Galvanized
⅛, ¼, and ⅜	50½%	24%	⅛ to 1¼	39½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	38%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	46½%	25%	⅛ to 1¼	39½%	24½%
½	51½%	39%			
¾ to 1¼	55½%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37½%	2	33½%	20½%
2½ to 4	51%	40½%	2½ to 4	35½%	23½%
4½ to 6	50%	39½%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York Black	New York Galvanized	Cleveland Black	Cleveland Galvanized	Chicago Black	Chicago Galvanized
⅛ to ¾ in. steel butt welded	47%	31%	43½%	34½%	57½%	44%
2½ to 3 in. steel lap welded	42%	27%	45½%	30½%	53½%	41%

Malleable fittings, Class B and C, from New York stock sell at list + 12½%
Cast iron, standard sizes, 10–5% off.

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in.	40½	3½ to 4½ in.	15½
2½ to 3½ in.	30½	3 to 3½ in.	1
2¼ in.	24	2½ to 2¾ in.	+1
1¾ to 2 in.	19½	2 to 2¼ in.	+16
		1¾ to 1¾ in.	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

Per Net Ton		Per Net Ton	
1 in.	$327	1¼ in.	$207
1¼ in.	267	2 to 2½ in.	177
1½ in.	257	2½ to 3½ in.	167
1¾ in.	207	4 in.	187
		4½ to 5 in.	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiation.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	10%
Coils to 1,000 ft.	15%
1,000 ft. and over	

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready

	Each, Net
Less than 12	$0.40
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—Following are warehouse net prices per 1000 ft. for conduit and per 100 for couplings and elbows:

	Conduit		Elbows		Couplings	
Size, In.	Black 1,000 Ft. and Over	Galvanized 1,000 Ft. and Over	Black 100 and Over	Galvanized 100 and Over	Black 100 and Over	Galvanized 100 and Over
⅜	$71.15	$76.25	$17.04	$18.18	$5.38	$5.74
½	71.15	76.25	17.04	18.18	6.28	6.70
¾	93.96	100.86	22.43	23.93	8.97	9.57
1	138.39	149.09	33.19	35.41	11.66	12.44
1¼	187.91	201.71	42.62	45.31	16.10	17.12
1½	224.68	241.18	56.82	60.62	19.89	21.15
2	302.29	324.49	104.17	110.77	26.52	28.20
2½	477.95	513.05	170.46	181.26	37.88	40.28
3	625.00	670.91	454.56	483.36	56.82	60.42
3½	779.24	834.44	1,003.82	1,067.42	75.76	80.56
4	945.03	1,010.43	1,160.08	1,233.57	94.70	100.74

5% cash 10 days.
From New York Warehouse—Less 5% cash.
Standard lengths rigid, 10 ft. Standard lengths flexible, ⅜ in., 100 ft. Standard lengths flexible, ½ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM—

Size I. D., In.	Feet per Coil	List, Ft.
⅜	250	$0.05½
½	250	.06
¾	250	.09
1	200	.12
1¼	200	.15
1½	150	.13
1	100	.25
1¼	100	.33
1½	Odd lengths	.40
2	Odd lengths	.55

Coils.....55% off
Less coils, 45% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.18	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	....
T. P. S. B.	.81	1.80	....
D. P. D. B.	.78	2.10	....
T. P. D. B.	1.35	3.60	....
T. P. to D. P. D. B.	.90	2.52	....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$16.75
No. 16 cotton twisted	22.00
No. 18 cotton parallel	19.80
No. 16 cotton parallel	25.75
No. 18 cotton reinforced heavy	30.00
No. 16 cotton reinforced heavy	36.50
No. 18 cotton reinforced light	23.40
No. 16 cotton reinforced light	27.50
No. 18 cotton Canvasite cord	26.00
No. 16 cotton Canvasite cord	28.50

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.25
35-amp. to 60-amp.	100	.35
65-amp. to 100-amp.	50	.90
15-amp. to 200-amp.	25	2.00
2-amp. to 400-amp.	25	3.60
02-amp. to 600-amp.	13	5.50

600-Volt	Std. Pkg.	Li-
3-amp. to 30-amp.	100	.40
35-amp. to 60-amp.	100	.60
65-amp. to 100-amp.	50	1.50
110-amp. to 200-amp.	25	2.50
225-amp. to 400-amp.	25	5.50
450-amp. to 600-amp.	10	8.60

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75 C
0-30 ampere, less than standard package	6.00 C

LAMPS—Below are present quotations in less than standard package quantities.

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.85	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.24
Hubbell composition No. 5467, standard package 50	.32
Benjamin swivel No. 903, standard package 250	.20
Hubbell current taps No. 5638, standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$14.00	$13.90	$25.00
12	13.25	15.70	18.05	30.70
10	18.30	21.00	23.85	41.50
8	25.54	28.60	32.70	56.77
6	.....	.....	51.40	.....
4	.....	.....	70.00	.....
2	.....	.....	101.80	.....
1	.....	.....	131.86	.....
0	.....	.....	160.00	.....
00	.....	.....	193.50	.....
000	.....	.....	235.20	.....
0000	.....	.....	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			Birmingham		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$11.25	$14.00	$31.00	$11.24	$15.39	$27.17
10	21.85	28.25	56.75	21.58	34.73	48.55
8	31.05	38.30	77.95	30.11	58.59	66.49
6	48.80	52.65	.....	59.28	82.11	.....
4	70.00	75.30	.....	84.86	118.86	.....
2	104.85	112.45	.....	.....	155.40	.....
1	136.85	146.15	.....	.....	188.86	.....
0	.....	194.25	.....	.....	228.90	.....
00	.....	239.60	.....	.....	279.30	.....
000	.....	294.00	.....	.....	338.50	.....
0000	.....	358.25	.....	.....	446.75	.....

Pittsburg—23c. base; discount 50%. St. Louis—30c. base.

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap.			¾ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.66

Less 1-5th standard package +20%
1-5th to standard package +10%
Standard package −15%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	36c. lb.
No. 18 B.&S. regular 1-lb. coils	37c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	48c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.120
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.3
200	4.40	6.76	10 14	13.50

Discounts:

Less than $10.00 list value	+ 5%
$10 to $25 list value	— 8%
$25 to $50 list value	—15%
$50 to $200 list value	—20%
$200 list value or over	—25%